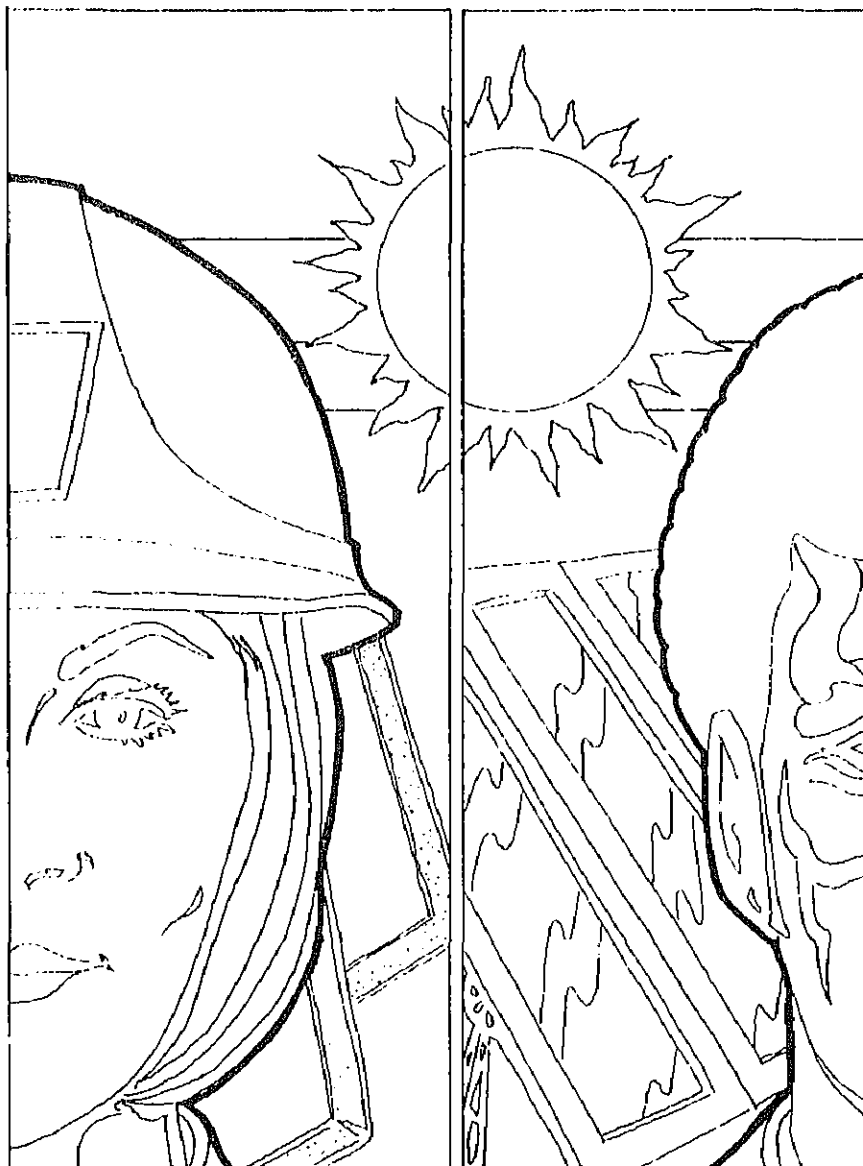




# Creating Jobs Through Energy Policy



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to policy decisionmakers both in defining the scope of their evaluation as in determining the availability and cost of information necessary to ask.

I fully recognize that the material in this handbook is terse, and substantial effort on the reader's part to work through. The nature of evaluation is such that there is no simple, step-by-step presentation to be used in all situations. However, this handbook will be periodically updated--both to take account of new data bases or methodologies, as well as to revise the overall presentation of material. For this purpose, readers' comments on the usefulness of this handbook for their particular policy needs are most welcome. Furthermore, policy analysts or decisionmakers who wish to use this handbook in developing employment impact studies may feel free to contact me for assistance.

Many individuals provided valuable input in completing this project. Some of the major reviewers are listed in the handbook as "personal contacts." Those that deserve special mention are Michael Kieschnick and Gregg Fels. The project evolved from an idea originally suggested to me by Michael. He helped me develop the methodology for determining informational requirements in Section I.

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July 1979

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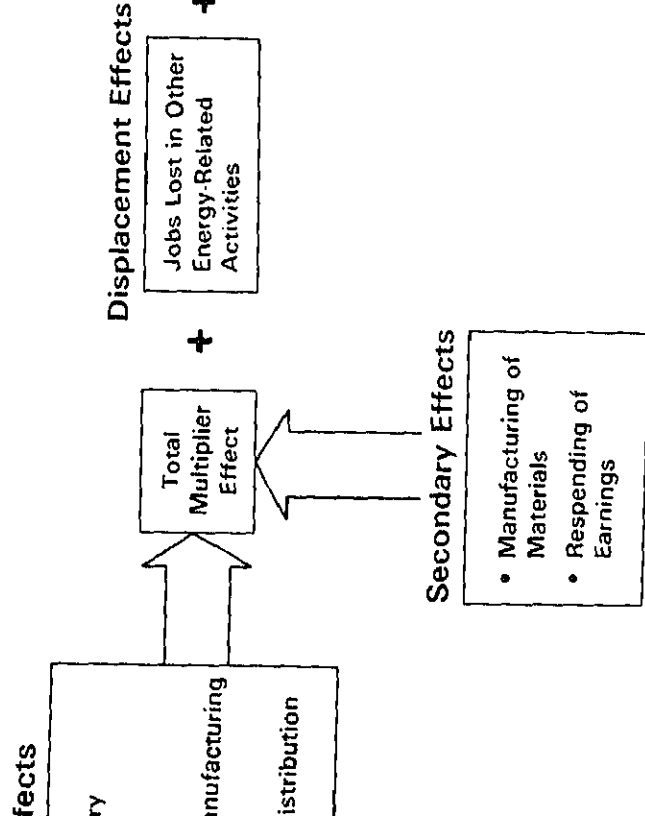
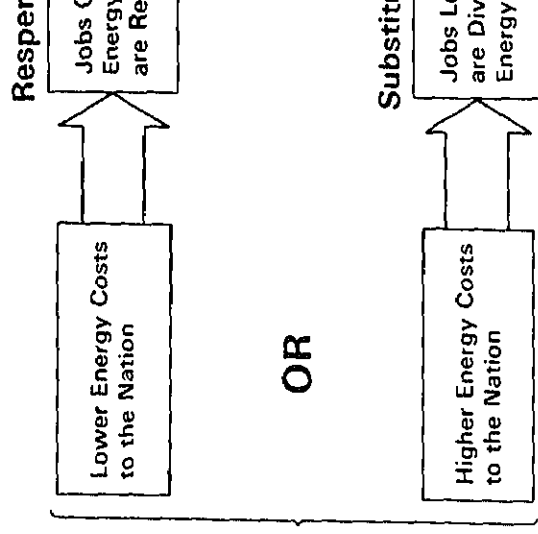
This handbook is designed to help national, state, and local decisionmakers make the following types of energy choices:

- o Whether to mandate energy conservation measures or to build an energy pipeline for importing energy into the region.
- o Whether to subsidize investment in the solar energy industry, or to continue to rely on conventional energy sources.
- o Whether to build a wood-fired powerplant or a nuclear plant to meet the electricity needs of the region.

In many of these cases, employment effects will be a factor weighing in making the choice among energy alternatives. This handbook will help decisionmakers with that part of the energy choice. Its focus is on the employment effects of energy development because job creation is one of the public issues for the national or local economy. Other important issues include the quality of growth, stability of income and the provision of public services ultimately depend on the number and quality of jobs. Local government services depend on tax flows, which stem from income which is earned from employment. The importance of creating and maintaining jobs dictates that policymakers take seriously the employment effects of public decisions, particularly those as fundamental as energy policy. At the same time, energy policy can serve as a policy instrument for communities that desire more control over job creation in their area. It is therefore no wonder that the debate over energy policy has focused on the job creation potential of energy alternatives.

Energy development in general can have several effects on employment. The overall (or "net") effect on employment will depend on the relative magnitude of the following factors (see figure 1):

- (1) The direct effect, or the effect on labor requirements for energy recovery, direct manufacturing, construction and general operation and maintenance (O&M) associated with the energy development. For example, solar energy development creates direct jobs in component manufacturing, installation, operation and maintenance, the construction and operation of backup power. For a power plant, direct employment includes the labor required for plant construction, resource recovery and transportation, turbine or generator operation and distribution.



to meet the demand for goods and services generated by the  
earnings associated with (1) and (2).

The combination of these three effects is usually referred to as the multiplier effect, which estimates the effects of a change in spending on one part of the economy on total economic activity (including employment) in the region.\* Most multiplier analyses (and data sources) only distinguish between the direct effects and "secondary effects"--that is, they combine direct and induced effects into a single component of the total multiplier. For the purpose of this handbook, these secondary impacts will be referred to jointly as "indirect/induced effects."

In addition to a positive multiplier impact, the energy choice can have a negative displacement effect on employment if it reduces the labor requirements associated with an alternative energy source. For example, a policy decision may be to promote nuclear energy as a replacement for oil and coal. In this case, the employment and earnings associated with fossil fuel extraction (3) would be reduced by the employment and earnings associated with oil extraction, conversion and distribution.

Furthermore, energy choices will have a responding/substitution effect if the energy source encouraged through policy measures incurs different costs than the next best alternative. If the energy source to be promoted is less expensive than its alternative,\*\* real economic growth (and hence employment and income growth) occurs as these resource savings are respending on additional goods and services. Conversely, an energy source that costs more per energy output than its alternative, and is made available to the

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section II, part 2 of this report for a discussion of multipliers.

For the Nation as a whole, "costs" refer to the marginal, unsubsidized price per unit of energy. For most solar systems and conservation methods, the price is equivalent to cost as defined above. For most conventional energy technologies, however, prices are significantly lower than costs because of government subsidies and pricing policies. As long as these subsidies are provided at the Federal level, however, it is unrealistic for local communities to factor them into their energy costs. This is because the cost of Federal subsidies is spread over the entire Nation. Hence, a particular community can be only negligibly affected (See section II, part 4).

... can decrease overall employment and earnings by diverting other (more labor-intensive) sectors of the economy.

Finally, the net employment effect of a policy choice will depend on the way the energy investment is financed. Finance refers to funds used to pay for an energy system, including public grants, tax credits, private expenditures combined with public funds, or funds alone (as in the case where a technology is mandated by law). If energy investment is financed through increased private spending, it will be diverted from other types of expenditures in or outside of the energy sector. This will offset some of the positive factors described above.

It is more likely, however, that public funds will be used for investment, either in the form of direct procurement or financing of the private sector.\* They will also divert spending from other parts of the economy, to the extent that public funds displace private funds. The magnitude of this displacement depends on the method used to finance the expenditures and prevailing business cycle conditions. There will be a one-for-one displacement of public for private funds if the public expenditures are financed through taxation. If, on the other hand, public expenditures are financed through debt, displacement will be greater when the financial markets are "tight" (e.g., during a recession) than when the economy is experiencing expansion.

Unfortunately, the analytical work in the area of energy and employment is limited.\*\* Most of it to date examines only the direct employment associated with new energy technologies, in particular solar energy, as compared to conventional alternatives. These studies for the same amount of useable energy:

- o Solar hot water, heating and cooling technologies, in residential applications, can create two to eight times more direct employment than conventional alternatives. In the case of liquified natural gas, where most of the direct labor is created in foreign countries, solar technologies can create 50 times as many direct jobs.

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\*It is possible that the energy investment will be financed by reducing public expenditures in other programs. In this case, the decision-makers also need to consider the employment effects of reducing these expenditures. However, budget reorientation is rarely used as a means to finance investments.

\*\*See: The Job Creation Potential of the Energy Sector

o Conservation measures (i.e., insulation, weatherstripping, storm windows, etc.) create 26 times as many direct jobs as LNG, but fewer direct jobs than nuclear and other conventional powerplants.

However, as mentioned earlier, direct jobs represent only part of the employment picture. In fact, the results of some recent studies indicate that direct employment effects can be a misleading indicator of both the magnitude and direction of total job creation. For example, the recent Federal Domestic Policy Review (DPR) of solar energy compares the direct and indirect employment effects of two accelerated national solar energy scenarios with employment over the 1978-2000 period.\*\* The study examines the labor requirements of 13 different solar technologies, taking account of the jobs displaced in the conventional energy sector due to increased solar penetration. Results indicate that total employment over the period for the accelerated scenarios is 3 to 10 million person-years higher than for the base case. Although these results indicate that accelerated solar energy strategies have a positive effect on overall employment, the magnitude of this effect is considerably smaller

than those implied by analyses that examine direct effects of residential applications only. Furthermore, the DPR did not consider the relative costs of energy under each scenario, nor did it take account of labor-saving production techniques that would probably be necessary to meet the level of accelerated demand for solar.

For cost-effective energy conservation alternatives, recent studies indicate that the total employment effects can be significantly positive. A study sponsored by the Department of Energy (DOE) assesses the national employment effects of achieving Federal energy conservation goals pertaining to

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is because most passive solar features are simple "add-ons" to conventional buildings, and do not require a significant increase in construction labor.

The Domestic Policy Review is an interagency task force mandated by President Carter to examine the barriers to widespread solar use, and to develop proposals for accelerating solar implementation. See: Domestic Policy Review of Energy: Final Report, Impacts Panel (Volume I) U.S. Department of Energy (October 1978) TID-28835/1.

generated as net energy cost-savings are respent in the economy.

The results of this study indicate that, in meeting the mpg standards, net employment in 1985 will increase slightly, but significantly (1 to 20 thousand person-years). For the retrofit program, net employment in 1985 will increase by up to 520 thousand person-years. Another report sponsored by DOE yields similar results for industrial cogeneration facilities.\*\* These results illustrate that direct employment alone paints an incomplete picture of the total job creation potential of conservation, particularly those that are cost-effective. What most people forget is that these energy cost-savings will be respent in the economy and create additional jobs. In fact, a recent study for the Joint Economic Committee indicates that the respending effect can be at least as large as the direct and second-order effects combined.\*\*\*

The extent to which direct employment is a misleading indicator of total employment depends primarily on the size and diversity of the economy in question. In the case of a small isolated township that imports most of its goods and services, direct employment effects would represent almost all of the total employment effects experienced by the region. On the other hand, direct effects will grossly misstate the total employment impact for the Nation as a whole, as the studies mentioned above indicate. Most decision makers are faced with energy choices for regions that fit somewhere between these two extremes. This makes the task of determining the total employment information needed to determine employment effects much more difficult. Furthermore, gathering information on the employment effects of energy choices can be costly in terms of time and resources. For many energy technologies, such as solar and conservation, detailed, industry-by-industry information on the total employment effects is simply not available. For other, more conventional systems, this information may be available, but it is costly to procure and utilize for the decision in question.

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\*Employment Impacts of Achieving Federal Energy Conservation Goals. P-1347, Institute for Defense Analysis, Arlington, Virginia. May 1978.

\*\*An Analysis of the Macroeconomic Effects of Industrial Cogeneration Development. JRB Associates, Inc., McLean, Virginia (September 1977).

\*\*\*Employment Impact of the Solar Transition. Prepared for the Joint Economic Committee, U.S. Congress, by Len Rodberg (April 6, 1979, U.S. Government Printing Office).

The purpose of this handbook is to help policy decisionmakers evaluate energy alternatives in terms of their employment potential. The decision may be a Government official on the national, state or local level; it may be a member of a community planning council, a community development corporation, or member of a non-profit research group. This handbook is designed to provide members of these groups with:

- o A working understanding of basic economic concepts and analytical methods that can be used to estimate the employment effects of energy choices;
- o A general framework for determining how much information on employment effects is relevant for the particular policy issue and the economy in question; and
- o Detailed references for where the information is available and the associated costs.

Serious study of this compendium may eliminate some of the need for consultants. Much of the information provided here can be utilized without employing professional economists. Some information, however, requires the use of more sophisticated modeling techniques that should be contracted for by professionals. At the very least, this handbook will help the decisionmaker evaluate the analytical work of consultants in the area of energy and employment.

The handbook is organized into two sections, with attached appendices. Section I presents a general conceptual framework for evaluating the employment effects of energy choices. It describes the various types of employment effects associated with energy development, and what factors affect the magnitude of these effects. It also provides a methodology for determining the amount and type of information needed to assess the total employment effects in a particular region.

Section II first provides a general description of how to use the handbook. It then presents a detailed listing of sources of information on direct employment effects (part 1), indirect/induced effects (part 2), multiplier effects (part 3), responding/substitution effects (part 4) and feedback effects (part 5). The availability and cost of this information is included. Each section is designed to provide the user with a working understanding of how these informational sources can be applied. Detailed instructions for further reading are also presented.

may be an implicit choice, such as a decision to continue supportive (e.g., tax incentives) to conventional energy sources. In either case, decisions will effect expenditure patterns in such a way that the demand for particular energy source increases. This, in turn, will alter the level of employment and earnings in the economy.

In order to accurately assess the overall effect of an energy choice on employment and earnings, decisionmakers will need information on the magnitude of the direct, secondary, displacement, responding/substitution, and multiplier effects discussed in the introduction to this handbook. But the amount of information needed will vary, depending on two major factors:

- (1) The policy question to be addressed; and
- (2) The degree of economic diversification in the region.\*

The Policy Question. The amount of information needed will vary, depending on whether the policy question is:

- (1) What is the total net employment/earnings impact of a policy to encourage energy technology A? The answer to this question will be in the form of absolute amounts, i.e., the policy will yield X jobs and Y income in the economy. For example, a policy to encourage state energy office might need to determine the employment effect of introducing a sizeable tax credit for solar energy development.
- (2) In terms of net economic impact, how does a policy decision to encourage technology A compare to one to encourage technology B? The answer to this question will be in the form of comparative amounts, i.e., the policy to encourage technology A will create (or less) jobs than a policy to encourage technology B. For example, a Community Development Corporation (CDC) might face a choice between investing in solar energy companies or firms that provide energy services.

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For purposes of this report, the geographic area included within a region is broadly defined as an economic unit--an area with economic relationships and interdependencies among industries. A region may refer to a small rural community and its service area, a large densely populated metropolitan area, or, at the far extreme, a massive region encompassing several states.



effects described above. However, significantly less information is needed for the second question. In particular, it is usually unnecessary to quantify the displacement effect when comparing energy alternatives that differ only in energy output. This is because, in most cases, the energy alternative is displacing the same energy source (in which case the decreases in requirements and earnings "cancel each other out"). Furthermore, in comparing energy alternatives that cost the same per energy output it is unnecessary to quantify the "financing effect," as long as the financing method is the same for both investments.

Finally, in comparing energy alternatives with unequal costs, it will be necessary to quantify the respending/substitution effect in the case where the alternative with the greater employment effect is also the most costly. In this situation it becomes unclear which alternative yields the greatest net effect, unless the respending/ substitution effect is also measured.

For example, suppose energy technology A creates 100 jobs per unit of energy while technology B creates only 50 jobs per unit. On the basis of employment alone, a decisionmaker would conclude that energy technology A is superior--because it creates twice as many jobs in the economy than technology B per unit of energy.

However, let us also assume that technology A costs \$100 per unit of energy while technology B provides energy at \$50 per unit. Furthermore, let us assume that at a dollar of personal disposable income spent in the economy creates 75 jobs. Promoting energy technology A would cost consumers \$50 more per unit of energy than technology B--which represents 75 jobs that would otherwise be created. Taking this "substitution effect" into account makes technology B more attractive. In fact, technology B creates twice as many jobs per dollar of energy as technology A when the substitution effects are included.

Degree of Economic Diversification. The amount of information needed to evaluate energy policy choices also depends on the degree of economic

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ly, the decisionmaker will need information on all of the effects and tradeoffs across different policy areas, where the investments are made for each other (except in a budgetary sense).

...economy, some (or exports), a larger portion of its output is sold outside the region. Similarly, the local economy buys (or imports) a larger portion of its goods and services from outside the region. The greater the proportion of exports and imports, the more undiversified (open) the economy.

Relatively limited information is needed for an economy where most of the materials for energy systems are imported, and most of the personal income is spent outside of the area. For this "highly undiversified" area, the analysis of the indirect, induced and respending (or substitution) effects would be "simplified." Furthermore, financing for the energy investment in a small, undiversified economy, will generally originate from outside the region (with the exception of direct local taxation). Hence, a decisionmaker attempting to compare two energy systems in terms of job creation in that area would, with a reasonable degree of confidence, base the comparison on direct effects only.

In contrast, for a well-diversified economy, direct employment effects are a misleading indicator of the total net employment impact. An analysis based on direct economic effects discussed above would fail to capture the significant secondary effects discussed above, and could lead to very misleading policy conclusions.

Tables 1 and 2 present a summary of the amount of information needed to evaluate energy policy choices, depending on the policy question asked and the degree of economic diversification in the region. As the tables indicate, the accuracy of direct employment effects as an indicator for total net employment effects within the region will be greatest when:

- (1) The economy in question is small and highly undiversified.
- (2) The energy choices have equal costs per energy output.
- (3) The policy question requires a comparative analysis of net employment impacts among energy alternatives.

Alternatively, the accuracy of direct effects as an indicator of total effects will be lowest when:

- (1) The economy in question is large and highly diversified.
- (2) The energy choices have unequal costs per energy output.

of a "small, highly undiversified" and a "large, highly diversified". Unless the region in question is a very isolated township or, in extreme, the Nation as a whole, the decisionmaker is still left with the problem of determining how much information is needed for an accurate estimate of employment effects. This requires a more detailed look at the relationship between economic diversification and the components of the total multiplier effect. Specifically, it is necessary to determine, for each region, the varying degrees of diversification, the proportion of the total multiplier effect that is captured by the direct effect only.\* If this proportion is sufficiently large (i.e., within the desired range of accuracy), the decisionmaker can save considerable amounts of time and financial resources by focusing the analysis on direct effects only. If the proportion of direct component of the multiplier is lower than the desired degree of accuracy, the decisionmaker is forced to devote the resources to estimate the indirect/induced effects as well as the direct.

In order to provide this information, individual regions must be "ranked" according to degree of economic diversification and grouped into generic economies. This generic economies enables the decisionmaker to draw conclusions about his own region, without the need for collecting and analyzing data specific to each region. This can save considerable amounts of time and resources. The drawback, however, is that predictions based on "reference" or "generic" economies are more uncertain than those based on region-specific data.

One means of achieving a ranking of economic diversification is to simply assign a number of distinct industrial sectors in each region assigned to each group. It follows that the larger the number of distinct industrial sectors in a region, the more diversified is the region. However, this procedure is very time consuming. Furthermore, disclosure problems at all levels of regional detail would tend to make this an inconsistent exercise at best.

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Estimating the informational needs for the other factors (i.e., displacement, multiplier, and responding/substitution effects) is relatively straightforward. In general, the displacement effect requires estimation only for impact analysis. It follows the same procedure as the multiplier effects, except that an alternative energy source is examined. In most cases the financing effect will require estimation, which can be done at fairly low cost (see section II, part 4). As a rule of thumb, the responding effect should be estimated whenever the multiplier effects have unequal costs. The exception to this rule is when a detailed cost-benefit analysis is required and only direct effects need estimation to achieve the desired degree of accuracy.

TABLE 1

Question (1) Comparison of Net Employment  
Impacts among Energy Alternatives

A. Equal Costs per Energy Output

Type of Economy	Types of Information		
	<u>Direct</u>	<u>Indirect/Induced</u>	<u>Displacement</u> <u>Resubstitution</u>
Large (diversified)	X	X	
Small (undiversified)	X		
B. Unequal Costs per Energy Output			
Large (diversified)	X	X	X
Small (undiversified)	X		

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\*Only if methods are different for each investment.

\*\*Only if direct taxation is used for one investment and not for the other.

TABLE 2

Question (2) Total Net Employment  
Impact of Energy Investment

A. Equal Costs per Energy Output

Type of Economy	Types of Information		
	<u>Direct</u>	<u>Indirect/Induced</u>	<u>Displacement</u> <u>Responding/ Substitution</u>
Large (diversified)	X	X	X
Small (undiversified)	X		**
B. Unequal Costs per Energy Output			
Large (diversified)	X	X	X
Small (undiversified)	X		**      X

---

\*Only if direct taxation is used for the investment.

\*\*Only if direct employment for displaced system is provided locally.

similar. This can be accomplished by first assigning economies to non-SMSA groups to distinguish between urban and rural economies.\* SMSA group can be subdivided into large and small SMSA's, based on population levels. All groups are then further subdivided into geographic regions, which characterize their economic structure. They are further described by their rates of growth, as suggested by Van Zele. The results are represented in figure 2.

Seventeen generic economies emerge from this classification scheme, each representing a group of specific regions with similar levels of economic diversification (see table 3). Furthermore, each of the 173 Bureau of Economic Analysis regions (see figure 3), SMSA's, and non-SMSA regions in the United States can be classified under one of these generic economies. A list of regions by corresponding generic economy is presented in tables E-1 through E-17, Appendix E.

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\*See: "On Measuring Economic Diversification," by Merlin M. Hackbart and Donald A. Anderson, in: Land Economics, LI 4, November 1975, pp. 7-14; "Concept and Measurement of Regional Industrial Diversification," by J. Conroy, in: Southern Economic Journal, Volume 41, No. 3, January 1975, pp. 492-505; "A Portfolio Theoretical Approach to Industrial Diversification and Regional Employment," by James Barth, John Kraft and Phillip Wiest, in: Journal of Regional Science, Vol. 15, No. 1, 1975, pp. 9-15.

\*\*Regional Analysis of Energy Development Impacts and Responses: Survey Methods, Results and Needs by Roger Van Zele (University of Pennsylvania Press, 1977).

\*\*\*A Standard Metropolitan Statistical Area (SMSA) is defined as a group of counties which contains at least one city of 50,000 inhabitants or more, or "twin cities" with a combined population of 50,000. Contiguous counties are included in an SMSA if they are socially and economically integrated with the central city. See: Statistical Abstract of the United States, U.S. Department of Commerce, Bureau of the Census, Appendix II.

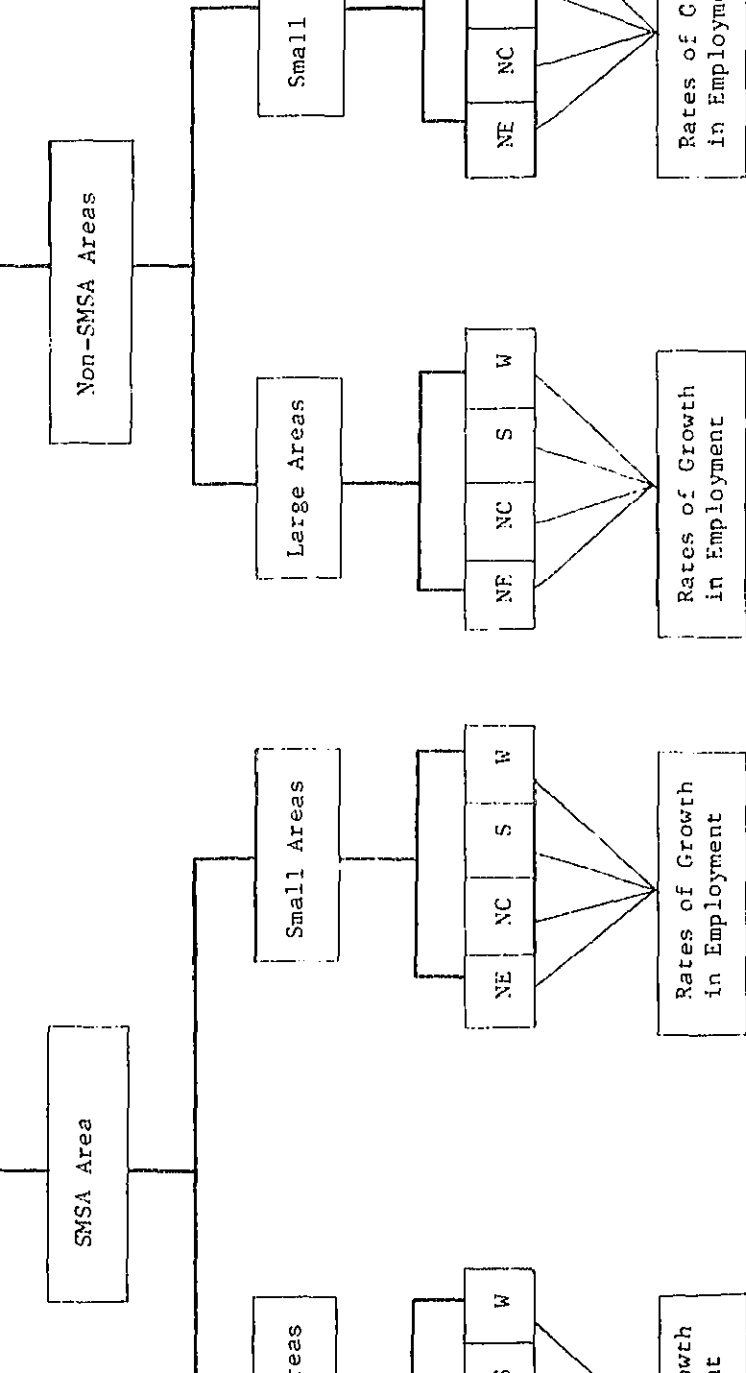


Figure 2: Diagrammatic Representation of Classification Scheme for All U.S. Regional Economies

Northeast

North Central

South

Regional Data	Growth Rate		Centralized Conventional Energy Systems		WECS	
	%	Rank	%	Rank	%	Rank
SMSA, Large						
1. North	1.07	17	55.0	17	55.9	15
2. South	2.11	8	60.5	15	57.9	14
3. West	3.15	5	55.1	16	55.2	16
SMSA, Small						
4. Northeast	1.17	16	63.5	14	64.5	13
5. Southeast	2.35	7	67.1	9	65.6	10
6. East North Central	3.39	4	67.7	8	65.9	8
7. West North Central	1.51	14	64.3	13	65.1	11
8. East South Central	3.09	6	64.4	12	64.9	12
9. Mountain	4.39	1	68.6	7	65.7	9
10. Pacific	4.00	2	72.2	4	69.7	6

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\*Including photovoltaics



Data	Growth Rate		Centralized Conventional Energy Systems		WECS		Solar Collect Technol
	%	Rank	%	Rank	%	Rank	%
A, Large							
	1.98	9	65.4	11	65.6	10	65.5
A, Small							
theast	1.22	15	66.0	10	67.1	7	66.0
theast	1.96	10	71.4	5	70.0	5	71.8
st North entral	1.62	13	70.0	6	70.9	3	70.0
st North entral	1.93	11	77.0	1	74.9	1	77.4
st South entral	1.91	12	74.0	2	71.6	2	74.4
st	3.83	3	73.2	3	71.0	4	73.6
S.A.	2.39						

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ng photovoltaics.

energy conversion systems and centralized conventional energy systems. Representative facilities are described in greater detail in Appendix 1. For each generic economy, the proportion of direct component-to-total effect associated with each of these representative energy systems is estimated. The results are presented in table 3.

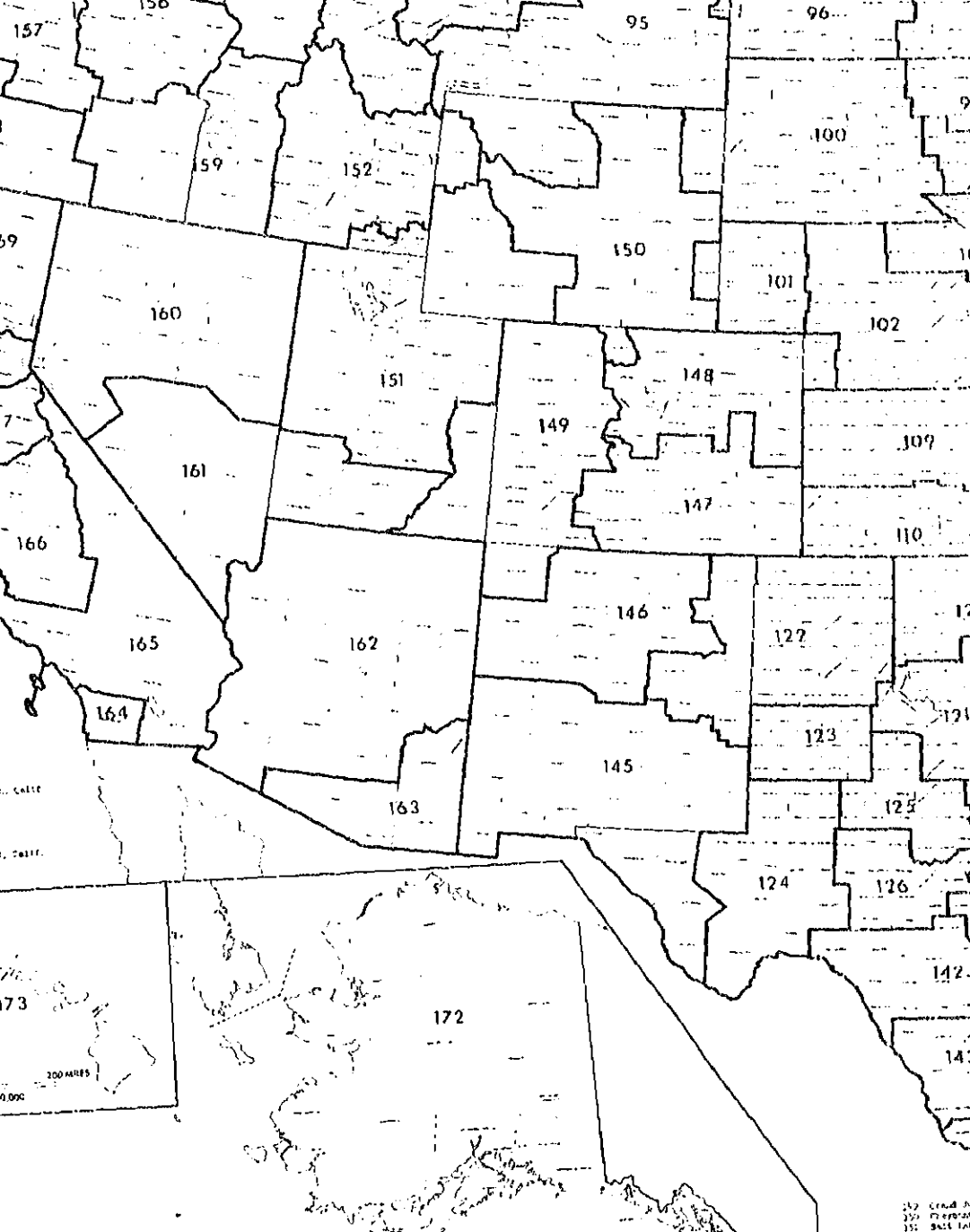
As indicated in the table, the amount of information needed to assess the employment effects of an energy choice varies significantly among economies. For example, the direct employment effects of an investment in centralized conventional systems for regions classified under Generic Economy 15, on the other hand, direct effects account for about 80 percent of the total employment effects. For Generic Economy 1, on the other hand, direct effects account for about 20 percent of the total employment effects. Hence, a decisionmaker facing an energy choice for a region similar to Generic Economy 1 would need to estimate direct and induced employment effects, whereas for a region similar to Generic Economy 15, an estimate of direct employment effect would probably be sufficient.

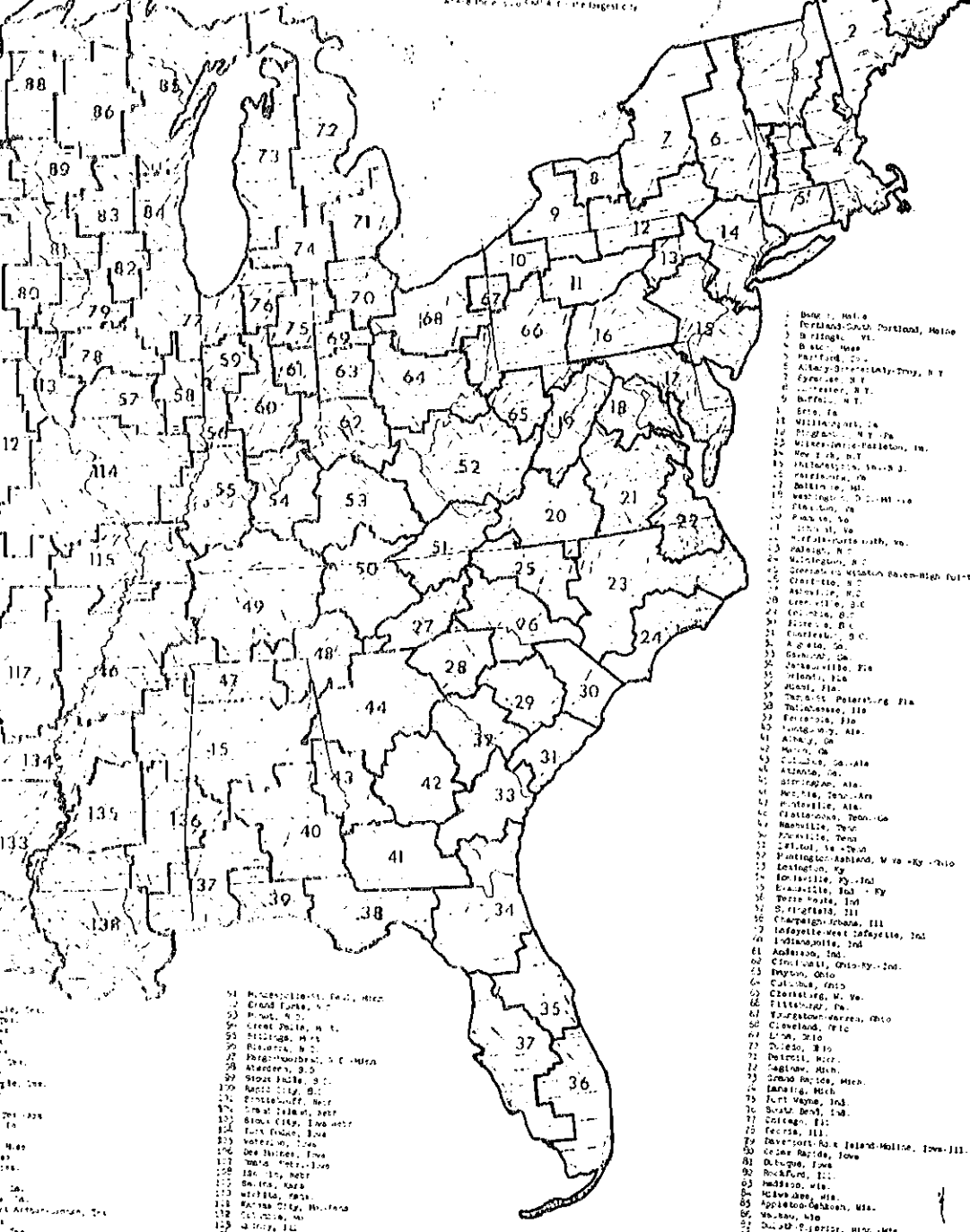
Note that the ratio of direct component-to-total multiplier consistently decreases as diversification increases. This is because the direct-to-total ratio depends on more than just an indicator of economic diversification: It depends on the specifics of the economy's structure and requirements of the investment project. For example, consider an investment undertaken in an economy whose industrial structure is such that a large amount of direct inputs can be supplied locally, but all indirect inputs are not locally supplied. The implication is that the economy is reasonably diversified and the total local multiplier may be significant. However, the direct component-to-total multiplier would be miniscule. Conversely, consider a situation in which few indirect requirements can be locally supplied but direct requirements can be locally supplied. Again, the total multiplier may be significant and the economy is fairly diverse. This time, however, the direct component-to-total multiplier ratio would be large. Reality, of course,

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\*See: A Method for Assessing the Size of Regional Multipliers and Components, by Gregg Ferris, Solar Energy Research Institute, Golden, Colorado (DRAFT, March 1979). The Institute will be publishing a detailed manual for developing generic economies and representative energy systems by fall 1979. A summary of the methodology used is presented in Appendix 1.

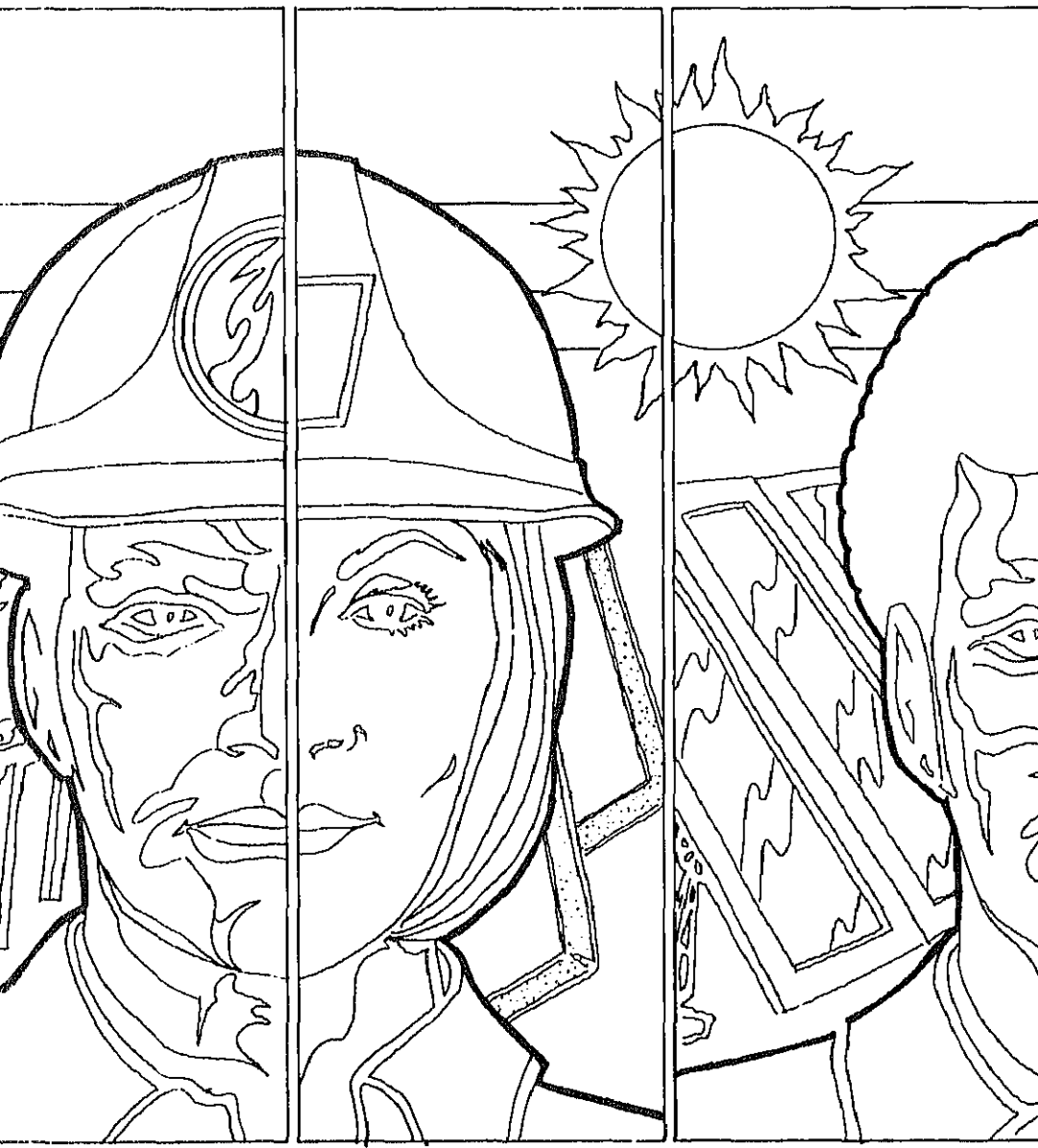
as described above, table 3 is designed to aid decisionmakers in meeting their informational needs for assessing the employment effect of policy choices. However, important qualifications must be attached to the data. Several notions of "generic" or "reference" cases have been used. Whenever reference data are used, potential users of those data must be reminded that the data probably do not describe nonreference experiences. This limitation also applies to any use of this table for regions larger than those specified in table 3. Users of this information are cautioned to consider the realities of the situation and apply the results judiciously. Despite these limitations, the data in table 3 provide a reasonably accurate guide to informational needs. For the reasons mentioned above, the table is not designed to be used in estimating the level of the employment multiplier or its components. These estimates should be based on data sources that are as specific as possible to the economy. The purpose of section II is to provide the user with information of this type.





- 1. Boston, Mass.
- 2. Portland, Maine
- 3. Burlington, Vt.
- 4. New York City, N.Y.
- 5. Albany, N.Y.
- 6. Syracuse, N.Y.
- 7. Philadelphia, Pa.
- 8. Erie, Pa.
- 9. Pittsburgh, Pa.
- 10. Harrisburg, Pa.
- 11. New York City, N.Y.
- 12. Washington, D.C.
- 13. Baltimore, Md.
- 14. Philadelphia, Pa.
- 15. New York City, N.Y.
- 16. Washington, D.C.
- 17. Philadelphia, Pa.
- 18. New York City, N.Y.
- 19. Washington, D.C.
- 20. Philadelphia, Pa.
- 21. New York City, N.Y.
- 22. Washington, D.C.
- 23. Philadelphia, Pa.
- 24. New York City, N.Y.
- 25. Washington, D.C.
- 26. Philadelphia, Pa.
- 27. New York City, N.Y.
- 28. Washington, D.C.
- 29. Philadelphia, Pa.
- 30. New York City, N.Y.
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- 32. Philadelphia, Pa.
- 33. New York City, N.Y.
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- 36. New York City, N.Y.
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- 51. Washington, D.C.
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- 95. Philadelphia, Pa.
- 96. New York City, N.Y.
- 97. Washington, D.C.
- 98. Philadelphia, Pa.
- 99. New York City, N.Y.
- 100. Washington, D.C.



attain the highest degree of confidence in an analysis of energy reality, however, there are cost, time and availability constraints on the ability of decisionmakers to obtain all the information needed. As indicated in table 3, the cost of making energy choices on the basis of the information is reduced confidence in the outcome. However, this is minimized if scarce resources are devoted to obtaining information on employment effects most relevant for the economy in question. The purpose of section I was to assist decisionmakers in assessing which types of information are most relevant for energy policy choices.

In addition, the "uncertainty" associated with energy choices is reduced as more detailed information on the relevant employment effects is available to decisionmakers. Unfortunately, there is almost always a trade-off between the level of detail and the level of costs, so that the constraints are a major limiting factor. Sources of information on employment effects of energy choices range from individuals who have access to data on the labor intensity of various energy technologies to complex computer systems that are available at relatively high cost. The purpose of this section is to present a list of relevant references for this type of information, starting with the simplest, least-costly sources to the most complex and expensive (see table 4). On the basis of section I, the decisionmaker can decide which types of information are the most relevant for his or her task. Then, using the references presented below, the decisionmaker can determine exactly where the information is available and at what cost. The following are six major steps to follow in using this compendium:

- o Step 1: Determine the level of economic diversification in question. This can be done using tables E-1 and E-2 and table 3 above, which allocate specific regions to specific energy systems.
- o Step 2: Determine how much of the total employment effect is due by the direct component alone. This can be done using table 4, which presents the direct component-to-total multiplier for various energy systems.
- o Step 3: Decide whether the degree of accuracy implied by the direct component-to-total is sufficient for the task. If it is not, the decisionmaker should proceed to step 4.

employment effects are within the budget. This can also be done using table 4.

- o Step 6: Determine whether the displacement, financing and response substitution effects require estimation. This can be done using 1 and 2. Informational sources on these types of effects are presented in section II, parts 3, 4 and 5.

A specific example will help to illustrate how this handbook can be used by decisionmakers on the national, state or local level: Suppose that a Community Development Corporation (CDC) in the El Paso, Texas SMSA area wants to assess the local employment impact of investing in solar collector manufacturing facilities. Assume that the financing for this investment will originate from a federal grant, and that the budget for the employment impact study is \$200,000.

Following the steps outlined above, the CDC decisionmaker should first refer to table E-1 in Appendix E and table 3. From table E-1, she/he learns that the economy of El Paso SMSA is approximated by Generic Economy 16. According to table 3, direct effects alone will account for about 75 percent of total employment effects. The decisionmaker decides that this level of accuracy is sufficient for the task.

Informational sources for direct employment, and their costs, are presented in part 1 of this section. Table 4 lists these sources by increasing cost, and directs the reader to the sections in part 1 that describe each source in more detail. In this example, the decisionmaker could use the following sources to estimate the number and types of jobs associated with solar energy development:

- o Individuals with access to labor-intensity coefficients;
- o Summaries of institutional studies, industry estimates and surveys;
- o Detailed Characteristics volumes from the 1970 Census;\*
- o Data tapes for the Brookhaven National Laboratory Input-Output Model, and the Regional Industrial Multiplier System;

---

For example, this particular source can be useful in determining the types of jobs associated with manufacturing of solar components and collectors, as long as the labor requirements are similar to those in most types of manufacturing.



- o The Bureau of Economic Analysis Regional Economic Information System (REIS);
- o The Bureau of Census "County Business Patterns";
- o The Bureau of Labor Statistics (BLS) data tapes.

The other sources listed in table 4 either cost more than the budget will permit, or else do not contain information applicable to decisions about solar technologies.

Since some of the data sources mentioned above contain national data only, the decisionmaker should also contact the local Employment Security Office and Local Buildings and Trades Council to make sure that the skills and equipment required are available locally. In addition, the decisionmaker may want to compare the employment effects of solar energy development to a "business as usual" projection, using REIS projections of employment and earnings for the area.

The next step is to determine how much information is needed to estimate the displacement, financing and responding/substitution effects. Table 1, section I, indicates that information on the displacement effects can be obtained only if the direct employment for any displaced energy is provided. To get a better handle on the displacement effect, the decisionmaker should look at any of the regional information sources (within the budget limits shown in table 4. In particular, the Bureau of Census County Business Patterns data may be useful in determining the size of local area employment in existing energy sectors. A call to the Local Buildings and Trade Council would also be helpful (and free of charge).

Table 2 also indicates that the financing effect does not require estimation for this example. This is because funds for the energy development will originate outside the local area, i.e., from the Federal Government. However, the responding/substitution effect does require estimation since solar provides energy at a different cost per unit than existing energy. Table 4 of this section can be used to evaluate the responding/ substitution effect.

The example described above is specific to community-level energy development choices. Choices that are made for larger regions--or the nation as a whole--would require different amounts of information. To use the component proportions in table 3 for regions that contain both SMSAs and non-SMSAs, the decisionmaker should first determine the proportion of the region's population that lives in SMSAs.

$$= \sum_{i=1}^n \frac{DCP_i \cdot E_i}{E_o}$$

re  $DCP_j$  = the direct component proportion of a region,  $j$ , composed of more than one generic economy

= the direct component proportion of generic economy  $i$  (e.g.,  $i$  = SMSA - Large)

= the level of employment in all the generic economies of type  $i$  in the aggregated region

= the number of the generic economies

= the level of employment in the aggregated region

er organizations may be able to afford larger budgets for employment analyses than the CDC in the example above. In this case, the maker will examine additional, "higher cost" informational sources used above. However, the general steps to follow in using this will apply in all cases.

rt 1. Direct Employment/Earnings Effects. The following sources provide information on the direct employment/earnings effects of energy

Individuals with access to labor-intensity co-efficients. The most approach to determining direct labor requirements for energy systems use national estimates of person-hours/mmBtu/year or person-hours/\$ cent for the particular energy technology. Several people in the Government and private sector have worked with studies that assess ratios for conventional as well as solar/conservation systems. These

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TABLE 4: SOURCES AND COSTS OF DIRECT AND INDIRECT/INDUCED EMPLOYMENT INFORMATION

- o National Information
- o Regional (Sub-national) Information

ment

<u>Source of Information</u>	<u>Sponsoring Organization</u>	<u>Cost of Information</u>
eo Individuals with Access to Information	--	free
eo Institutional Studies, Industry Estimates	--	free
o Local Building and Trade Councils	AFL-CIO	free
o Social and Economic Assessment Model (SEAM)	Argonne National Laboratory	free
o Brookhaven National Laboratory Laboratory Input - Output Model (BNL/I-O)	Brookhaven National Laboratory	free
o Regional Industrial Multiplier System (RIMS)	Bureau of Economic Analysis (Bea), U.S. Department of Commerce	free
o North Dakota Regional Environmental Assessment Program (REAP)	North Dakota REAP	free
o Solar Energy Research Institute (SERI) Data Base	SERI	NA
o Environmental Impact Statements	Atomic Industrial Forum, Inc.	\$ .25 per page
o Energy Supply Planning Model Data Base	Bechtel National, Inc.	\$ 5 - \$ 75

Source of Information

Sponsoring Organization

Cost of Information

o Bureau of Labor Statistics Input - Output Model (BLS/I-O)	Bureau of Labor Statistics (BLS), U.S. Department of Labor	\$ 65 - \$100 <sup>a</sup> /
oo U.S. Department of Labor Construction Manpower Demand System	U.S. Department of Labor	76 - 300
oo BLS Data Bank Files	BLS, U.S. Department of Labor	0 - 285 <sup>a</sup> /
• "County Business Patterns" and "Detailed Characteristics" Volumes from 1970 Census	Bureau of Census, U.S. Department of Commerce	10 - 320
• SEAM	Argonne National Laboratory	b/
• Arizona Economic Demographic Projection Model (EDPM)	Office of Planning, Arizona	50 - 75
o BLS/I-O	BLS, U.S. Department of Labor	100 <sup>a</sup> /
• Utah Process Economic and Demographic Impact Model (UPED)	Office of State Planning Coordinator, Utah	150
o Brookhaven I-O/BESOM System	Brookhaven National Laboratory	100 - 300 <sup>b</sup> /c/
• RIMS	BEA, U.S. Department of Commerce	Up to \$1,000
• Bureau of Reclamation Economic Assessment Model (BREAM)	Bureau of Reclamation, Denver, Colorado	680 - 800 <sup>b</sup> /

es only.  
 e procedure for the use of this model has not yet been established.  
 time only; data is free of charge.

TABLE 4 (continued): SOURCES AND COSTS OF DIRECT AND INDIRECT/INDUCED EMPLOYMENT INFORMATION

Employment Direct/Induced (continued)	Source of Information			Sponsoring Organization		Cost of Information
	National Information Regional (Sub-national) Information					
	State Survey - Based Input - Output Model		State Energy Offices, Universities, Utilities			\$ 100 - \$1,000
	Regional Science Research Institute Model (RSRI)		Regional Science Research Institute			500 - 1,350
	INFORM Model		University of Maryland			5,000
	Energy Systems Research Group Model (ESRG)		Energy Systems Research Group			6,000 +
	REAP		North Dakota REAP			\$30,500 for adaptation to other regions
	Lawrence Berkeley Laboratory Model		Lawrence Berkeley Laboratory			Up to \$100,000

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9700 S. Cass Avenue  
Argonne, Illinois 60439  
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Leonard Rodberg  
515 N. 110 Street  
Apt. 7G  
New York, New York 10025  
202/483-3321 or 212/662-2463

Robert A. Herendeen  
Energy Research Group  
333 Advanced Computation Bldg.  
Urbana, Illinois 61801  
217/333-7168

William F. Hahn, Coordinator  
Construction Labor Demand System  
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200 Constitution Avenue, NW.  
Washington, D.C. 20210

William R. Schriver  
Project Manager  
Forecasting and Analysis Office  
Tennessee Valley Authority  
327 Miller's Building  
Knoxville, Tennessee 37902  
615/632-3714

Paul Paskert (415/768-5775), or  
Michael Gallagher (415/768-7949)  
Bechtel National Inc.  
P.O. Box 3965  
San Francisco, California 94119

B. Summaries of institutional studies, industry estimates and surveys  
Several recent studies have compiled data on the direct labor requirements

On the basis of institutional studies, industry estimates, environmental statements and reports, the number of employees required for manufacturing construction, operation and system design were determined. The results of these studies are presented in tables A-1 through A-20 (appendix A). These studies can select pertinent information from these tables and make additions to this data when other, more specific information is available.

C. Local building and trade councils are sources for free information on the availability of local labor for over 15 construction crafts. Most councils can also provide information on the skills needed for a particular energy project, on the basis of past experience. There are 450-480 councils throughout the country. Phone numbers are available through the Building Construction Trades Department, AFL-CIO (815 16th Street, NW., Washington, D.C.; phone: 202/347-1461; Contact: Guy Roth).

D. Environmental Impact Statements (EIS) are a good, inexpensive source for information on the employment effects of energy projects. The Atomic Industrial Forum, Inc. (INFORUM) maintains an extensive library and bibliography of EIS's (and Environmental Reports) for fossil fuel and nuclear power projects and transmission lines. Most EIS's require information on the employment impacts of the energy project, although the quality of the analysis varies widely from statement to statement. The projects are classified by type of the facility, but are cross-referenced by geographic region and other categories.

#### Cost and Availability of Information:

INFORUM will provide copies of the EIS (or Environmental Reports) or sections of the reports (e.g., the employment impact section) for \$0.25 per page. Contact:

Elizabeth Hannon  
INFORUM  
Atomic Industrial Forum, Inc.  
1016 16th Street, NW.  
Washington, D.C.  
202/833-9234

E. The Bechtel data base for the Energy Supply Planning Model (ESPM) contains detailed national average cost and employment information on 101 selected energy facilities (see tables C-1 and C-2 in appendix C). Each facility is designed in terms of an average size and type of technology and

construction costs, which include primarily labor, material, equipment costs; (2) land costs; (3) general plant (e.g., facilities shared by a vertically integrated company like the yard of an electric utility which services a powerplant transmission lines); (4) tangible assets (e.g., licenses, patents); (5) escalation during construction--this compensates for inflation and other cost increases occurring during the construction period; (6) interest during construction; and (7) working capital (e.g., special funds). These cost estimates are in January 1978 dollars and are presented in total (as opposed to annual amounts). They are based primarily upon in-house engineering estimates by various divisions of Bechtel Corporation. In addition, this data base matches material and equipment costs by appropriate BEA sectors (see section K(2b)). Although labor costs (i.e., capital cost per unit of energy output or unit of capacity) are not explicitly present in the data base, this information is derived from the background documentation on each facility.

- o Operating and Maintenance Costs -- O&M costs for each facility are presented in this data base. These costs are segmented into six major categories and 25 minor categories. The former are: (1) labor; (2) materials; (3) equipment; (4) utilities; (5) rent; materials and equipment costs correspond directly to comparable categories under capital costs. In addition, these costs are presented in January 1978 current dollars. The cost estimates were initially determined by Stanford University, but updated periodically by Bechtel.
- o Labor Requirements -- For each facility, labor requirements are estimated for both the construction and O&M phases. Labor requirements, which are presented in thousand person-hours, are listed under two general groups: non-manual and manual.

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\*This summary of the Bechtel data base was drawn from: A Review of Bases For Energy/Employment Analysis in an Input-Output-Framework, (Consad Research Corporation, prepared for Department of Energy (DOE) 1979). Contact: Norman Seltzer, DOE, Intergovernmental and Institutional Relations (202/252-5931). The ESPM model can also be used by the public, although the costs may be prohibitive for local groups. For more information, contact: Dr. Phiroze Nagarvala, Bechtel National, Inc., P.O. Box 39, San Francisco, Ca. 94119 (415/768-8555).



- o Length of Construction Period -- The length of the period for each facility is included in this data presented in both number of years and the proportion activity which will be completed during each
- o Materials Requirements -- About 49 selected materials items, which are used in the construction of each facility, are contained in the data base. The quality of materials used during the operating phase of each facility are noted in the data base.

Technical reports on the Bechtel data base are available through the National Technical Information Service (NTIS) 5285 Port Royal Road, Springfield, Virginia 22161, at their listed prices (typically between \$5 to \$10). Reports of primary interest in this area are:

Escalation in the Costs of Manpower, Materials and Equipment for Energy Facilities. Bechtel Corporation, San Francisco. (October 1978) Report #PAE 3794-F.

Resource Requirements, Impacts and Potential Constraints Associated with Various Energy Futures. Bechtel Corporation, San Francisco. (October 1978) #PAE 3794-9.

The Bechtel data base is also available on computer tapes, which can be obtained for about \$75 and are currently being updated. Contact

Paul F. Paskert (415/768-5775)  
or Michael Gallagher (415/768-7949)  
Bechtel National, Inc.  
Post Office Box 3965  
San Francisco, California 94119

F. The Department of Labor has developed a low-cost, easily used model to determine national or regional labor requirements by construction-related construction projects. The Construction Manpower Demand model can forecast, for periods up to 10 years in the future, the construction labor requirements for:\*

\*CMDS also forecasts construction labor requirements for residential and non-residential buildings, and non-building (non-energy) structures. This type of information would be useful for evaluating the labor requirements of various construction projects.

- o Uranium Mining, Refining, Processing and Storage.
- o Petroleum Production, Refining, Processing and Transportation
- o Natural Gas Development, Processing, Production and Transport
- o Other Energy Projects and Facilities (including Hydroelectric

S provides information on monthly labor requirements over the construction period for 29 construction crafts.

In addition, CMDS provides information on five on-site technical occupations (e.g., engineering and management) two non-technical (e.g., electrical) on-site occupations, and operation and maintenance (O&M) requirements by occupation for all energy projects. The CMDS also generates the monthly bill over time by craft, as well as materials and equipment costs, aggregated to two-digit Standard Industrial Classification (SIC).\*

The model also forecasts monthly labor demand (by craft) for all construction activity in the region. This information can be used by regional state planners to determine whether a new energy construction project will cause supply bottlenecks in certain craft categories. The Department of Labor releases a report on total construction manpower demand for each state once or twice a year. Upon special request, the DOL can provide this information by Bureau of Economic Analysis (BEA) regions (see figure 3 in Section 3).

The cost of a report on monthly manpower requirements (by craft) for a single facility in a region is \$76. The cost of demand forecasts for total construction manpower is:

by state	\$0
by BEA region	\$200-\$300

For further information, contact:

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Published employment statistics usually follow the classification scheme in the Standard Industrial Classification Manual, Executive Office of the President, Bureau of the Budget (U.S. Government Printing Office, 1972). For a brief but excellent discussion of this classification scheme, see: Making Sense Out of Dollars: Economic Analysis for Local Government (November 1974, pp. 14-16). Available from the National League of Cities, 1620 Eye Street, N.W., Washington, D.C. 20006.

G. The Solar Energy Research Institute (SERI), data base, in summer 1979, will contain detailed national cost and employment on 16 solar-related technologies (see exhibit 1). The cost estimation parameters developed for this data base were based primarily on data supplied to SERI by DOE national laboratories (e.g., Argonne, Los Alamos, Lawrence Berkeley Laboratories, Oak Ridge). This information in

- o Capital Cost -- Estimated capital cost for 16 solar technologies are contained in this data base. These costs are projected for the years 1975, 1985, 1990, and 2000 and are expressed in 1972 dollars per  $10^{12}$  Btu output. Subsequently, coefficients are developed to coincide with those INFORUM data supplied the necessary inputs for the construction of the facility.\*\* The data base can be readily matched with BEA sectors, to be used for similar input-output analysis.
- o Operating and Maintenance Costs -- O&M cost estimates for 14 of the 16 solar technologies in the SERI data base were not developed for the passive solar and solar stoves technologies. As with the capital costs, the estimates are given in millions of 1972 dollars per  $10^{12}$  Btu output and are disaggregated by

INFORUM sector.\* These estimates, however, assume a constant distribution of O&M costs among input sectors remain constant over time. Therefore, technical coefficients do not change over the projected years 1975, 1985, 1990 and 2000.

- o Labor Requirements -- This information will be available in the SERI documentation.

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\*The summary provided here is based on a report by CONSAD, op. cit.  
\*\*INFORUM is a 200-sector input-output model, designed to produce economic projections over a 10 to 15-year time horizon. See part 2, section 2.

1. Active Solar
2. Passive Solar
3. Solar Thermal

#### Agricultural and Industrial Process Heating (AIPH)

4. Parabolic Dish AIPH
5. Parabolic Trough AIPH
6. Flat Plate AIPH

#### Photovoltaics

7. Residential Photovoltaics
8. Centralized Photovoltaics

#### 9. Large Wind Energy System

##### Collection System

10. Agricultural/Forestry Residue Collection
11. Biomass Farm Production
12. Municipal Solid Waste Electric Utility

##### Conversion Systems

13. Manure Gasification - Anaerobic Digestion
14. Agriculture/Forestry Gasification Pyrolysis
15. Biomass Wood Stoves
16. Biomass Electric Utility System

documentation of each solar technology. As previous SERI is expected to be publishing a background documentation data base by spring 1979. This report will specify facility size.

- o Operating Life of the Facility -- This information is in the SERI data base.
- o Materials Requirements -- This information is not in the data base, but it will be available as part of the background documentation.
- o Technological Change/Input Substitution -- As indicated the data base provides estimates of capital coefficients for the sectors for the years 1975, 1985, 1990 and 2000.\* Coefficients are projected over this period. Thus, the model can be used to estimate input substitutions occurring with technological change.

Availability and Cost of Information. Following approval by the Energy Research Administration (sometime in fall 1979), this data base will be available for public use. Cost of data is not yet determined.

**Contact:**

(for employment information)  
Gregg Ferris: 303/231-1077  
SERI  
1536 Cole Boulevard  
Golden, Colorado 80401

(for cost information)  
Michael Yokell: 303/231-1060  
SERI  
1536 Cole Boulevard  
Golden, Colorado 80401

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\*INFORUM is a 200-sector input-output model, designed to produce projections over a 10 to 15-year time horizon. See part 2, section 2.1.

H. The U.S. Department of Commerce, Bureau of Economic Analysis, (BEA) releases earnings and employment data as part of its Regional Economic Information System (REIS), available upon request. Most of this data is put into the Regional Industrial Multiplier System (RIMS), which is described in part K of this section. The BEA can provide both historical data and projections to 2020.

### Historical Data:

- o Personal Income (e.g., labor and proprietors income, social insurance contributions, interest, dividends, rent and transfer payments) by county, state and for the nation. Available for 37 sectors at the state level (see table C-3 in appendix C ) and 16 sectors at the county level.\* State data is available for selected years 1929-1958, and consecutive years 1957-1977. County data is available for selected years 1929-1965 and consecutive years 1966-1977.
- o Employment by county, state and for the Nation. Available for 37 sectors at the state level and 16 sectors at the county level. State data is available for 1967-1977; county data is available for 1967-1977 (consecutive).

### Cost of Information

Individual tables: \$1 per county or state and  
\$1 per table with a  
\$5 minimum  
\$50 (maximum) for all counties in a state  
\$50 for National total  
\$1,000 for one table for all counties and  
states and the United States total.

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These sectors are: farm, agricultural services/forestry/fisheries, mining, construction, non-durable manuf., durable manuf., transportation and public utilities, wholesale trade, retail trade, finance/insurance/ real estate, government services, Government and Government services (Federal, civilian, military, local).

The BEA also publishes a nine-volume set of publications entitled U.S. Personal Income, 1971 to 1976, which contains estimates of total personal income, population, per capita personal income, components of personal income, and labor and proprietors' income by major industries for all United States counties, the District of Columbia, SMSA's, BEA economic areas, and the Nation. These volumes are available from:

National Technical Information Service  
5285 Port Royal Road  
Springfield, Virginia 22161

Cost of Information.

The price for the nine-volume set is \$75; the Accession number is B163-SET. Titles, Accession numbers and prices for individual volumes follow:

Vol. 1: Summary, PB 291 164	\$11.00
Vol. 2: New England Region, PB 291 165	\$ 5.25
Vol. 3: Mideast Region, PB 291 166	\$ 6.50
Vol. 4: Great Lakes Region, PB 291 167	\$10.75
Vol. 5: Plains Region, PB 291 168	\$12.50
Vol. 6: Southeast Region, PB 291 169	\$16.25
Vol. 7: Southwest Region, PB 291 170	\$ 9.25
Vol. 8: Rocky Mountain Region, PB 291 171	\$ 6.50
Vol. 9: Far West Region, Including Alaska and Hawaii, PB 291 172	\$ 6.50

employment. Projections of total employment to 2020 by BEA Economic  
area (see figure 3 in section I) are available in:

1972 OBERS Projections, Volume 2: Concepts, Methodology,  
and Summary Data. 1974)\* This document is available  
from the United States Government Printing Office,  
Superintendent of Documents, Washington, D.C. 20402  
(202/275-3050). Cost: \$2.50

Earnings. Projections of earnings (i.e., wages, salaries, and  
proprietors income, accounting for about 80 percent of Personal Income)  
2000 for states by 37 industrial sectors are available from BEA.  
Contact:

Gene Janisch (202/523-0958)  
Regional Economic Analysis Division  
Mail Stop BE-61  
Bureau of Economic Analysis  
Washington, D.C. 20230

In addition, projections of earnings for 1980, 1990, 2000, 2010, and 2020  
by 16 industrial sectors are available for the states listed below.  
Information can be ordered from:

•  
National Technical Information Service (NTIS)  
5285 Port Royal Road  
Springfield, Virginia 22161

the ordering information shown:

: Projections, Economic Activities in...

ia	PB 264 580	\$9.75
Carolina	PB 264 581	\$5.50
cky	PB 264 582	\$9.00
Carolina	PB 264 583	\$7.75

document also include earnings and income data which has been  
ly updated by BEA. The sources for this updated data are listed



Virginia	PB 264 585	\$
Mississippi	PB 264 584	\$
Tennessee	PB 260 538/AS	\$
Florida	PB 260 537/AS	\$
Alabama	PB 260 536/AS	\$
Summary	PB 265 473/LL	\$

Microfiche copies are \$3 each.

The above employment and earnings projections were developed under a contractual arrangement. BEA is preparing updated projections this year. Earnings and employment will be projected in 58- in population by age and sex, and income by source. The results for states, SMSA's, BEA economic areas, and "state-pieces" of regionalizations. These projections are described in:

The BEA Regional Projections Program: An Overview  
Kenneth P Johnson, U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Analysis Division, Washington, D.C. 20230.

I. Bureau of Labor Statistics Data Files. Current data on earnings by industry in state and metropolitan labor markets are derived from two primary sources: The Current Employment Statistics and the ES-202 Reporting System which provides data on employment covered by the State Unemployment Insurance laws. The BLS 790 report, hours and earnings estimates are available only for the 200 and 220 major metropolitan areas while the ES-202 data are available for all states.

The BLS 790 industry employment estimates are based on monthly employment in firms in major industries throughout each state. Data from these employment sample surveys are inflated by appropriate factors to estimate total non-agricultural payroll employment in major industries in the nation and for the 50 states. The industry payroll employment estimates for the nation as a whole, the individual states, and major SMSA's are published in Employment and Earnings, a monthly publication of the U.S. Department of Commerce, Bureau of Economic Analysis.

In addition, the State Employment Security Agencies publish monthly estimates of non-farm payroll employment for both the state and for selected major metropolitan areas throughout the state. Data for the manufacturing sector are generally broken down by two-digit Standard Industrial Classification (SIC) codes since the sample size for the manufacturing sector in the survey is large enough to justify such disaggregation. Payroll employment estimates for the remaining sectors are provided in a highly aggregated form due to sample size limitations.

Sources of this type are described in greater detail in:

A Manual For CETA Prime Sponsors

Second Addition, December 1976

National Civil Service League

5530 Wisconsin Avenue

Washington, D.C. 20015

(202) 654-8864

Cost: \$45 per copy

Economic/Demographic Assessment Manual

J. A. Chalmers and E. J. Anderson

November 1977. Copies are available,

free of charge from:

Bureau of Reclamation

Engineering and Research Center

Denver Federal Center

Post Office Box 25007

Denver, Colorado 80025

Attention: 922 (Contact: W. W. Reedy,

Division of Planning Technical Services)

Individual data tapes with the finest level of industry and geographic detail on employment and earnings are also available from the Bureau of Economic Statistics (BLS). These include:

o Industry Employment, Hours and Earnings

- National. For all employees, women, and  
production or non-supervisory workers nearly

Cost: \$110

industries at various levels of aggregation. About 1,300 published monthly series are available for production workers average earnings. Hours and earnings are available for more than 350 industries. Most series begin in 1958, although some are available from 1909.

- o Industry Employment, Hours, and Earnings - State and Area. For total payroll employment, over 8,800 series of monthly data are available; they cover each state and 227 major labor areas (most of which are SMSA's). About 10,000 monthly series covering workers average earnings for each state and 192 major labor areas, beginning in 1947 or later. In the largest states, up to 170 industries are reported. Some industry detail at the 4-digit SIC level is available for recent years.

Cost: \$2

- o Industry Employment and Wages (Covered by Unemployment Insurance laws). Two files are available: A historical file and a six-quarter file. The historical file contains national and state summaries of monthly employment, quarterly wages, and a number of reporting units by 1972 SIC industry. National summaries are available for 84 two-digit, 423 three-digit and 451 four-digit manufacturing industries. State summaries are available for 84 two-digit industries. These series begin in 1975.

Cost: de  
upon the  
specific

The six-quarter file contains state summaries, for the most recent six quarters, of monthly employment and quarterly wages. The summaries are available for 84 two-digit and 423 three-digit industries and for 1,004 four-digit industries.

Note: Chapter 3 - "Employment Hours and Earnings"

Chapter 9 - "Employment and Wages Covered by Unemployment Insurance Laws"

Contact: Carol Utter (202) 523-1146  
Bureau of Labor Statistics  
Office of Employment Structure and Trends  
Division of Current Employment Analysis

Table 5 provides a useful conversion chart of the various data categories from Federal sources. With this chart, researchers can convert census survey data to sectors corresponding to the major group divisions of the SIC and sectors on which the BEA reports personal income, wages and salaries, and reports employment and labor force statistics.

Care must be taken, however, in comparing census employment data with data from either BEA or the state employment agencies, since each is defined differently. The conceptual differences among these series principally have to do with: (1) whether employment is counted on a place-of-work or place-of-residence basis; (2) whether employment is counted as the number of jobs or the number of employed persons; and (3) whether employment counts only non-agricultural wage and salary workers covered by unemployment insurance compensation. The BEA includes agricultural workers, proprietors and uninsured workers. The differences among these series are explained in more detail in:

Economic/Demographic Assessment Manual

J. A. Chalmers and E. J. Anderson

Available from the  
Bureau of Reclamation  
Engineering and Research  
Denver Federal Center  
Denver, Colorado 80225  
Attention 922 (pages 48-51)

The Bureau of Census, U.S. Department of Commerce, is an excellent source of information on employment and earnings. Detailed profiles of the

Mining	Mining	Mining
Manufacturing (all types)	Manufacturing	Manufacturing
Railroads, Railway Express	Transportation,	Transportation
Service, Trucking and	Communications, and	
Warehousing Service	Public Utilities	
Other Transportation,		
Communications		
Utilities & San. Serv.		
Wholesale Trade	Wholesale & Retail Trade	Wholesale Trade
Food, Bakery & Dairy Stores		Retail Trade
Eating & Drinking Places		
General Merchandise Stores		
Motor Vehicle Retailing		
& Service Stations		
Other Retail Trade		
Banking & Credit Agencies	Finance, Insurance,	Finance
Insurance, Real Estate &	and Real Estate	
Other Finance		
Business Repair Services	Services	Services
Private Households		
Other Personal Services		
Entertainment & Reception		
Services		
Hospitals		
Health Serv., except Hospitals		
Schools & Colleges (pvt.)		
Other educational & Kindred		
Serv.		
Welfare, religious & Non-profit		
Membership		
Organizations		
Legal, Engineering & Misc.		
Professional Serv.		
Public Administration	Government: Federal,	Government
Schools & Colleges (Govt.)	Civilian, Military,	
	State & Local	

---

Source: Impact Analysis and Local Area Planning: An Input/Output  
A. Harvey Block, Center for Community Economic Development  
(Cambridge, Massachusetts 1977)

occupations and industries of the employed labor force are presented in considerable detail, including the occupational composition of employment in major industries of the SMSA's, SMSA counties, central and metropolitan counties. Detailed Characteristics volumes also report on the earnings of workers in various occupations and industries, including breakdowns of the occupational earnings data for various age, sex, and race groups.\*

The Bureau of Census also publishes County Business Patterns, a series of publications produced each year since 1946 that presents quarterly employment and payroll statistics by county and industry for each state. Information is provided on the number and type of operating units, payroll and employment by industry classification and county location. These reports are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20401. Each report (there is one for each state) costs less than \$10.

It should be noted that County Business Patterns includes only data for employment covered by social security, derived from employers' quarterly payroll returns. Thus, government employees, self-employed persons, farm workers, and domestic service workers are excluded. In 1973, County Business Patterns employment data accounted for about 75 percent of total United States employment. In urban counties and SMSAs, the major exclusion is government employment. Government agencies should be able to provide this supplemental information. In particular, each state department of labor in 1977 published a directory of available state statistical series. This directory shows what data exist on employment, wages, and unemployment by available level of geographic, industrial, occupational detail, and the frequency of publication.

Census employment/earnings information is also available on data tape from the Bureau of Census.\*\* The County Business Patterns data for 1974 to

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for example see: U.S. Department of Commerce, Bureau of Census, Detailed Characteristics: Massachusetts, PC(1)-D23, table 180, "Occupation of Employees by Industry Group and Sex," pp. 894-833, Washington, D.C., U.S. Government Printing Office, October 1972. The occupation-industry data from the Census are primary inputs into the 1976-1985 occupational forecasts for counties and SMSA's developed by about 20 State Employment Security Agencies throughout the Nation. Other states utilize data from the Occupational Employment Statistics survey for projection purposes.

The reports for County Business Patterns provide summary data for all SIC industries in the county with 50 or more employees. The data tapes provide data for all SIC industries.

Customer Services Branch  
Data User Services Division  
Bureau of Census  
Washington, D.C. 20233  
301/763-2400

K. Use of Regional/National Models. The direct employment of an energy project can also be estimated using existing regional models. There are several types of models used to estimate the employment effects associated with some change in a local or regional economy. The models discussed here are export base and input-output models. The models are discussed in greater detail in part 2 of this section. The purpose of this section is to briefly describe the procedure for determining direct employment effects using these models, and present the sources and costs for the information.

(1). Export Base Models. There is only one export base model that provides reliable estimates of the direct employment requirements for energy projects directly in the data base. This is the Social and Economic Assessment (SEAM), developed by Argonne National Laboratories. A highly simplified diagram in figure 4 illustrates the four major components of SEAM, requirements, output and interrelationships.

(1a). The SEAM model first projects the annual change in the population of the subject county (or combination of counties) by age and race to the year 2000.\*\* The user then inputs the type of technology introduced into the county and the year in which construction will begin. The model determines the annual direct construction and operation employment for that particular technology and estimates the lagged second-order effects using employment multipliers constructed from data on individual counties or counties.\*\*\* Direct employment requirements are es-

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\*This information is in the "population file" of the Sixth County Summary Table, 1970 Census.

\*\*The data base includes all counties on the mainland United States and the State of Virginia.

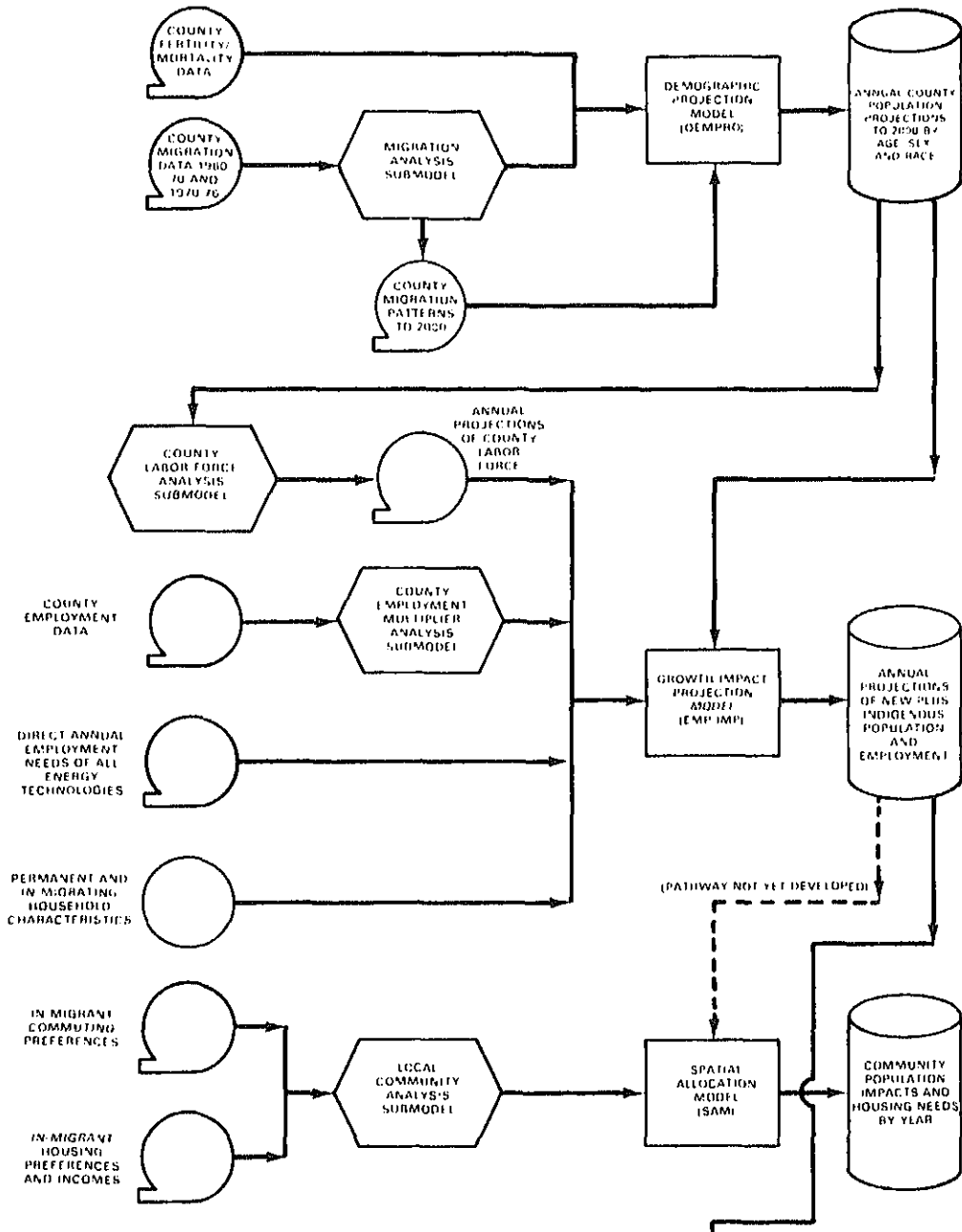
\*\*\*See part 2 for discussion of these multipliers.

## PRIMARY DATA

## DATA MANIPULATION

## SEAM MODELS

## MODEL OUTPUT





1. Coal Extraction Activities (county-specific)
2. Coal-Fired Plant (Base Plant Construction and O&M only)
3. Nuclear Plant (PWR) (Base Plant Construction and O&M only)
4. Oil Plant (Base Plant Construction and O&M only)
5. Gas-Steam Plant (Base Plant Construction and O&M only)
6. Combined-Cycle Base Plant (assumed similar to coal-fired plants)

The estimates for electric power facilities are based on a joint manpower study entitled Forecasts of Cost, Duration and Manual Man-Requirements for Construction of Electric Generating Plants 1977-19 study examines annual craft requirements to construct all planned progress electric powerplants for a range of sizes for each type of capacity. It also provides work-year schedules for the coal, oil and technologies with a capacity base size of 500 megawatts and construction of 4 years.\*\* For nuclear facilities, a base capacity size of 800-used with a standard construction duration period of 6 years. These are input to the Employment Impact Projection Model (EMPIMP) component SEAM. The EMPIMP can compute a new schedule when the specified meg size is greater (or less) than the base capacity size.

The SEAM model also computes available labor force for these facilities by subtracting the county-specific labor work force participation rates (by age, cohort and sex), from the corresponding national figures to obtain the percentage of unemployed in the local work force who, if sufficient jobs existed, be available to work. The model also determines household labor force characteristics of transitory workers, how many workers and households will move into the area. This component of the model also permits estimations of the potential demand for residential housing of housing in the communities accessible to the facility. Finally, the model determines, for each year of plant construction and operation, the requirements for public services and facilities (e.g., schools, recreation, police, fire) needed to accommodate the new population and the annual and operating costs of providing this infrastructure.

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\*Estimates are all provided for the incremental periods of 1975-1985 and 1985-1990.

\*\*The data base for this study was based on the Construction Manpower System (CMDS) described in part 1.F.

model further assumes that in-migrants are the first to be released for workers is reduced.

limitation to this model is that it assumes zero labor competition experiencing energy development and its adjacent counties. Thus, ng industrial development is explicitly included, the SEAM model at none takes place. If, in fact, industrial development is e county (or adjacent counties) for which local labor is qualified, overstate labor availability and the direct employment effects h the energy system in question.

tors limit the model to compute only rough employment trends. the SEAM model is, to date, one of the most comprehensive and ilable for analysis at the county level.

ork is presently underway to include important variables to the ill make its forecasting much more accurate and useful to the nmaker. Argonne National Laboratory is also in the process of eric solar energy systems as input into the SEAM model.

#### Availability of Information:

t, there is no official procedure for the use of SEAM by other than Argonne National Laboratories and the Department wever, the direct labor requirements of a particular facility can ree of charge, from the following persons:

J. Stenehjem  
gy and Environmental  
stems Division  
nne National Laboratory  
South Cass Avenue  
nne, Illinois 60439  
) 972-3754

Roger Shull  
Ronald Matheny  
ronmental Impacts Division  
l USDOE  
ington, D.C. 20545  
) 353-3311

"Summary Description of SEAM: The Social and Economic Ass  
technical memo ANL/IAPE/TM/78-9. Erik J. Stenehjem, Argon  
Laboratories. Energy and Environmental Systems Division.

"A Framework for Projecting Employment and Population Chan  
Energy Development Phase I and II," (Draft) Erik J. Steneh  
Metzger. Energy and Environmental Systems Division. Augu

(2). Input-Output Models. Input-output (I-O) models pres  
interindustry description of the national or regional economy.  
models are based on detailed industry-by-industry survey data.  
models can also be based on regional survey data, but are usual  
simple "top down," non-survey adaptations of national models.\*

For both types of I-O models, employment/income effects ne  
"localized." That is, there needs to be a procedure for determ  
of employment/income that is retained within the region, given  
final demand for the output of an energy sector (or any other i

The general procedure for "localizing" direct employment a  
effects in input-output models is as follows:\*\*

(a). Determine the industry sector(s) affected by the ene  
project and estimate the dollar level of final demand for each  
This step involves:

---

\*A "top down" approach determines regional trends or impacts by  
allocating national patterns to regional and state levels. An  
tive approach is to use regional data as input for a specific r  
model, as in the case of survey-based state I-O models. Using  
from specific and independent models to determine results for a  
aggregated region is often called the "bottom-up" approach. Se  
2, section (D)4 for further discussion of non-survey models.

\*\*For a detailed description of how nuclear powerplant requirem  
"localized" for the Philadelphia SMSA region, see: Regional Eco  
Nuclear Power Plants by W. Isard, T.A. Reiner and R. Van Zele (1974)  
Available from Brookhaven National Laboratory, Upton, New York.

requires purchases from the sawmill, concrete products, real concrete and diesel fuel industries.\* The process of breaking down an energy project (or any other investment) into primary purchases is usually referred to as developing a bill of goods for the investment.

- o Converting the direct output changes into final demand changes in the sector. This usually involves removing wholesale or retail and transportation margins from the sales figures and allocating them as final demand to the trade and transportation sector.

(b). Determine which industries are present in the region. In case a particular industry input is required, but not produced in the region, that input (and industry) is deleted. In effect, this assumes that the input is imported.

(c). For the remaining industry sectors determine whether there is sufficient local production in a given supplying industry to permit local purchase of the input. This can be done using a location quotient. Location quotients are measures of the degree to which a region produces the industry's input it needs. For a given industry, the location quotient ( $L_i$ ) is the industry's proportion of regional total earnings or employment divided by the proportion for the Nation.\*\*\*

$$L_i = \frac{e_i/e}{E_i/E}$$

where  $e_i$  is earnings/employment in the region in industry  $i$ .

---

Regional Employment and Income Effects of a 50--MW Wood-Fired Powerplant  
Peter VanderWerf. Thayer School of Engineering, Dartmouth College, Hanover, New Hampshire 03755 DSD #90.

See: The Use of Input-Output Analysis, Regional Development and Planning Evaluation, U.S. Department of Agriculture. Agriculture Handbook No. 530-72. Also, see: Net Energy Analysis: Handbook for Combining Process and Input-Output Analyses by Clark Bullard et al. CAC Document No. 214, Center for Advanced Computation, University of Illinois (Urbana Champaign; 1976).

\*Note: For national analysis,  $L_i$  would be equal to one.

represents 2.5 percent of United States total earnings. For the midwestern SMSA, assume that 4 percent of earnings in the region originate in this industry. According to the formula above, the location quotient is 1.61, that is, the midwestern SMSA produces more food and kindred products than it needs and exports the excess. Hence, for each dollar of final demand in that industry, all of it can be met by local production. The location quotient is 1.0 in the application described below (i.e., it will never be greater than 1.0 within the I-O analysis). If, on the otherhand, only 1.5 percent of earnings in the midwestern SMSA originated from this industry, the location quotient would be only 0.60. This implies that the region can only meet 60 percent of final demand in that industry through local production. It imports the rest.

Multiplying the total change in final demand by this location quotient yields the final demand change for the region by sector:

For each sector:

$$\begin{array}{lcl} \text{Change in Final Demand} & \times & \text{location quotient} \\ (\$1,000) & & \end{array} = \begin{array}{l} \text{Change in Final Demand Within Region} \\ (\$1,000) \end{array}$$

In many regional models, the change in final demand within the region is presented as a "direct effect coefficient."

$$\text{Direct effect coefficient} = \frac{\text{Change in Final Demand Within Region } (\$1,000)}{\text{Change in Final Demand (in } \$1,000)}$$

(d). The change in final demand (or the direct effect coefficient for the region is then multiplied by the direct employment coefficient (person-years per dollar of output) for the relevant sector. This yields the change in direct regional employment (in person-years) due to a change in demand for inputs:

The direct employment effects can be translated into earnings using the appropriate earnings/employment ratios:

ector:

$$\text{Employment} \times \frac{\text{Earnings/Employment}}{\text{Ratio}} = \text{Direct Earnings Effects}$$

Alternatively, earnings associated with direct employment effects can be using earnings/output ratios:

ector:

$$\text{Final Demand} \times \frac{\text{Earnings/Output}}{\text{Ratio}} = \text{Direct Earnings (income effects)}$$

Input-output models have this basic format for determining direct effects.\* However, they differ in the level of industrial sector aggregation, in particular, the level of energy sector disaggregation. Below is a list of national/regional I-O models that are available, with a description of their structure, disaggregation, and references for further information and use.

The Brookhaven National Laboratory Input-Output Model (BNL/I-O) is a national I-O model of the national economy, with total output employment and demand forecasted for 1985.\*\* The BNL/I-O model can be linked to a linear programming submodel of the energy sector and/or to macroeconomic models that use final aggregate demand (see part 2). The 110 sectors are listed in appendix C. The model currently includes 8 energy end-product

exceptions are I-O models tied to demographic models, where the labor force is actually projected and "matched" to the labor requirements with a new basic industry (such as energy). See, for example, the structure of the REAP model, section K(2c) below.

The BNL/I-O model was developed in collaboration with the Center for Advanced Studies at the University of Illinois, Urbana, IL.

Availability and Cost of Information:

- o Earnings and Employment/Output ratios for the 110 nation forecasted to 1985 are available, free of charge, from:

Paul Groncki (516/345-2071)  
Joan Lukachinski (516/345-2249)  
Brookhaven National Laboratories  
Upton, New York 11973

- o National Industry-Occupational matrix for 110 sectors and occupations are available, free of charge, from:

Paul Groncki/Joan Lukachinski  
(see above)

(2b). Regional Industrial Multiplier System (RIMS). The RIMS is designed to estimate regional impacts of changes in final demand of industries, and is used primarily to analyze site-specific impacts from energy-related activities. The model generates estimates of direct/indirect/induced changes in output, earnings and employment for industrial sectors. As in the case of the BLS I-O (see below), technologies, conservation methods and other "unconventional" energy must be broken into direct inputs and assigned to appropriate industries. Appendix B refers the reader to recent attempts to incorporate energy and conservation measures into the I-O framework. RIMS multipliers are derived from the production relationships listed in the 1967 BEA National Income Table. They are provided for each of the 173 BEA economic areas (see section I) and have been used to derive multipliers for every county and nine census regions. The state and census models disaggregate multiplier effects into 103 industrial categories. The census model also covers aggregated industries (see table C-5 in appendix C).

Availability and Cost of Information:

- o National earnings - output ratios and direct-effect coefficients by BEA region are available for 56 aggregated sectors in

more than 56 sectors, the cost of obtaining information on direct effects in BEA regions is the same as obtaining information on direct, indirect, and induced effects (see part 2, section D(4b)).

References:

Selected Analytical Data for Regional Impact Analysis: Procedure and Guide to Application, prepared for FEA by the Regional Economic Analysis Division, BEA, U.S. Department of Commerce, September 1976.

The Economic Impact of Oil Resource Development on the Alaskan Economy, 1975-85, FEA/B-76/082, prepared for FEA by the Regional Economic Analysis Division, BEA, U.S. Department of Commerce, September 1975.

Guideline 5 Regional Multipliers, Regional Economic Analysis Division, Bureau of Economic Analysis, U.S. Department of Commerce, January 1976.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price: \$2.00  
Stock No. 052-045-000-48-7.

Personal Contacts:

Joseph Cartwright (202) 523-0594

Regional Economic Analysis Division  
Bureau of Economic Analysis, BE-61  
Department of Commerce  
Washington, D.C. 20230

David Sandoval - Department of Energy  
Room 6119, 12th and Pennsylvania Avenue  
Washington, D.C.

(2c). The North Dakota Regional Environmental Assessment Program (R) provides baseline and energy project impact projections for a 15-county area in northern North Dakota. Outputs are available at the county and municipal levels and include such variables as employment by type\*, population by age and sex.

\*Types of employment in this model are: construction, operation, indirect support, and indigenous (i.e., baseline) jobs.



Personal income also are available at the regional level). The REAP model contains five basic submodels: an input-output economic model, a demographic model, an economic-demographic model interface, a residential allocation model and a fiscal impact model.

The REAP input-output model provides baseline projections of gross volume from which employment requirements by each of 13 sectors are derived (table C-6A in appendix C). The user must select the energy projects included in the energy development scenario to be evaluated. The model consists of 31 projects which are various possible configurations of export coal-fired thermal electric generating plant or substitute natural gas plant characteristics. Characteristics (including direct labor requirements) for each typical plant of each type are presented in tables C-6B to C-6D in appendix C.

The REAP demographic model provides projections of population by age group and sex and an estimate of the available labor force. The interface component provides projections of required employment from the input-output model with projections of available labor force from the demographic model to determine the level of employment needs that can be met by the indigenous population and what must be met by the in-migration of new workers for each county and county subarea. The residential allocation model estimates the settlement patterns for new workers and their families and the fiscal-impact model provides projections of the changes in public sector costs and revenues resulting from the anticipated economic and demographic changes. The REAP model can be used to provide preliminary conclusions about energy development in the western states, but is not appropriately applied to the specific, 15-county area. Other regions can purchase the model and adapt it to their regional economic and demographic characteristics (see part 2, section D(6)).

#### List of Information:

- |  |  |
|--|--|
| o Direct labor requirements and annual expenditures for 31 energy projects | Free of charge,<br>Contact: Glen<br>Schaible (see below) |
|--|--|

References: (available free of charge)

The REAP Economic-Demographic Model: Background Structure and Application by F. L. Leistritz, et al., prepared for U.S. Department of Energy by the Dakota Regional Environmental Assessment Program.

February 1978).

User Handbook (and Updates). Available from Director of User  
ND-REAP, 316 N. 5th Street, Suite 521, Bismarck, North Dakota

cts:

thaible  
Coordinator  
Environmental Assessment Program  
, 316 N. Fifth Street  
North Dakota 58505  
(3700)

The Bureau of Labor Statistics Input-Output Model (BLS/I-O) provides  
ates of total output by sector and total employment by sector and  
the years 1980 and 1985 for alternative assumptions.\* The I-O  
on the 484-sector matrix developed by the BEA, and has been  
o 129 industrial sectors by the BLS.

first determines the levels of output in 129 sectors required to  
ific forecast of final aggregate demands.\*\* Sectoral employment  
n estimated, based on projected employment/output ratios for each  
ectors are listed in table C-7 in appendix C, together with the  
Industry codes from the Standard Industrial Classification (SIC).  
oyment/ output ratios used to estimate employment changes are also  
e table. Note that the model includes final demand sectors for

---

dded by the BLS gives the user the option of choosing alternative  
de oil and alternative scenarios regarding economic conditions  
esent and 1985.

sts are usually derived from the output of a macroeconomic  
put is then used as input into the BLS I-O model. See, for  
Input-Output Simulation Procedures" technical memo TM/IA/78-03,  
Analysis Division, Energy Information Administration, U.S.  
Energy (July 31, 1978).

## Availability and Cost of Information:

- o Earnings and employment/output ratios for 129 industries are from BLS on data tape for 1970, 1980, 1985 and 1990. The data includes input/output coefficient matrices; total final demand components, civilian employment; and wage and salary employment series by industry with additional annual data for 1991. Cost: \$100.

Individual tables on national employment and output can also be free of charge, from:

Charles Bowman (202) 523-9036  
Bureau of Labor Statistics  
GAO Building, Room 4860  
Washington, D.C. 20212

- o National industry-occupational matrix for 260 industries and occupations is available on data file from BLS. For each industry-occupation cell, three data items are provided--employment of industry, employment to occupational total, and ratio of employment to occupational total.

Matrices are available for 1970, 1976 and 1985 (projected). Industry-occupational information for national employment is available, free of charge, from:

Neal Rosenthal (202) 523-1765  
Bureau of Labor Statistics  
441 G Street, NW.  
Washington, D.C. 20212

---

\*A joint effort by DOE and BLS is underway to develop a sectoring procedure from an energy perspective, which would isolate energy producing industries consuming large amounts of energy and industries consuming large amounts of energy per output. The Energy Disaggregated Input/Output (EDIO) model will disaggregate the electric utilities sector into fossil fuel, nuclear and "other" sectors. The EDIO model is currently under development.

a detailed discussion of the methods and data utilized by BLS in the construction of the entire BLS/I-O model, see:

U.S. Department of Labor, Bureau of Labor Statistics,  
Office of Economic Growth, "Methods and Data Sources:  
BLS Revised 1980 and 1985 Projections," unpublished  
monograph, April 1977.

BLS data files, write to:

U.S. Department of Labor  
Bureau of Labor Statistics  
Division of Planning and  
Financial Management  
441 G Street, NW.  
Washington, D.C. 20212

2. Indirect/Induced Employment and Earnings Effects. The simplest and most costly approach for determining the secondary employment and earnings of energy alternatives is to use the national estimates provided in institutional studies and/or contact individuals who have worked with sources of information (see Part 1, sections A and B above). While this is an appropriate starting point, it may be very inaccurate in cases where (1) an impact analysis is needed and the secondary effects for a particular region are significantly different from the national effects, or (2) a distinction between energy alternatives must be made and each has very different secondary effects on the local economy.

An alternative approach is to use a form of multiplier analysis which is specific to the region and energy technology in question. Multiplier analysis measures the effects of a change in spending in one part of the economy on total economic activity in the region. For example, suppose an electric powerplant is to be built in region A. Some fraction of the money spent on wages, salaries and equipment for building and running the plant will go to local businesses, and some of this increased income will, in turn, be spent in the local economy. As a result, retail merchants and other local businesses will enjoy higher sales. The expanded payrolls will be spent on basic needs such as food, clothing and housing. Hence, the original dollar outlays for the powerplant may generate two or three times as much income

indirect/induced effects can be easily estimated as the difference between total (multiplier) effects and the direct effects discussed in part approaches used most frequently by regional economists for this purpose: export-base multipliers, using either income or employment, and input-output models.\*

A. Export base multipliers: A general description. The underlying theory of export base\*\* is that exports are the moving force that drive the total level of local economic activity. The logic goes like this: demand from export activity is determined mainly outside of the local economy; export sales generate labor and business income which, in turn, generates demand in the local economy. Some of this income is spent in the local economy on purchases of goods and services, thereby generating still more income/employment in the region. In other words, if income or employment from export sales is added to the total income/employment will be multiplied.

Export base theory assumes all economic activity in a region can be divided into two sectors: the export sector produces goods and services for export

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\*Econometric models, a third approach, depend less on export-base theory and more on defining employment as a multivariate function of several explanatory variables whose coefficients are estimated with regression equations. This approach overcomes many of the problems associated with multipliers. Unfortunately, these models are expensive to develop and with few exceptions have not been effectively applied to energy policy choices. A recent report by the Council on Energy Policy Planning Agencies estimates that Wisconsin and Arkansas have each spent about \$300,000 in developing an econometric model. This cost does not even include the salary and overhead costs of State personnel involved in the effort. For purposes of this report, only the export base multipliers and input-output models will be discussed in detail. For further information on econometric models, see: Econometric Analysis of Regional Systems, Norman J. G. Williamson (Academic Press, 1977). For one of the few energy applications of the econometric model, see: Forecasting Regional Economic Activity: The Tennessee Valley Model, by Richard Gustely, Center for Business and Economic Research, Business Administration, University of Tennessee, Knoxville, Tennessee (1978)--Chapters III and IV.

\*\*Export base theory is also often referred to as economic base theory. The two terms are synonymous.

There are three major variations to the export base multiplier approach: simple ratios, complex ratios, and regression coefficients. Use of the simple ratio gives a picture, at one point in time, of the relationship of basic industry to non-basic, or service industry activity. The simple equation for this relationship is:

$$MV = \frac{TE}{BE}$$

MV is the multiplier value, TE is total employment and BE is basic employment.

The underlying assumption in simple ratios is that all employment in the basic sectors is assumed to be basic. Mining, construction, agriculture, and manufacturing are usually assumed to be basic, although other assumptions may include such sectors as transportation. This normally results in an underestimation of the real value of the multiplier by the portion of economic activity in non-basic sectors that is actually local service oriented. This particular method is best used for areas with large, relatively stable economies, or where there is poor input data.

The complex ratio differs from the simple ratio in the definition of basic employment. Each sector can have both a basic and non-basic employment component. Unlike the simple and complex ratios, however, the basic/non-basic mix for each point in time is assumed to remain the same throughout the assessment period.

The regression multiplier allows estimation of individual multipliers for each basic employment category. Unlike the simple and complex ratios, regression multipliers provide for more than just a one time period picture of the multiplier. Regression equations can be used to measure the effects of time, economic growth, construction phase and economic base changes. Due to increased availability of data, these multipliers can be applied to areas which are undergoing rapid change and/or have a small economy.

An alternative to using employment is to use income directly in computing the multiplier. Use of an income multiplier has one major advantage: it makes allowance for the difference in wage rates paid for various types of employment. Unfortunately, most available income data is out of date (e.g., BEA and BLS data have at least a 2-year lag) and industry or business sources are reluctant to

Export base multipliers have the advantage of being relatively simple theory, construction and use. As a result, it is relatively inexpensive to develop these multipliers: According to one estimate,\* the study of a community with 25,000 employees would cost less than \$5,000, a figure well within the range of community budgets of cities of that size. However, there are several significant conceptual and technical drawbacks to the use of export base multipliers in assessing the effects of energy choices:

1. Problems in identifying basic and non-basic sectors can detract from the accuracy of the forecasts. Several methods used implicitly assume uniform national consumption and production patterns, or that all local demand is met by local production.\*\*
2. The assumption of a constant basic/service ratio may not prove valid in the long run due to import substitution that accompanies regional growth. This is particularly relevant for an energy project, where the project is expressly undertaken for the purpose of substituting imported energy with local energy sources.
3. The multiplier, as an average for the basic sector as a whole, may not be applicable to a particular industry or energy project. The effect of a given industry or energy project on a region will be dependent on its propensity to consume locally produced intermediate products and on the consumption habits of its employees.

This last restriction implies that all energy projects that fall into a specific basic sector (e.g., construction) will have the same indirect/induced effects under this method of analysis. In effect, comparisons among energy alternatives (policy question 2) based on total employment/earnings effects are no more enlightening than comparisons based on direct effects alone. The use of export base multiplier analysis is really only appropriate for assessing the total impact of a policy decision to develop a particular energy source (policy question 1).

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The Community Economic Base Study, C. M. Tiebout, Committee for Economic Development, Supplementary paper No. 16, New York, 1962.

For a discussion of these types of inaccuracies, see: Econometric Analysis of Regional Systems by Norman Glickman (Academic Press, 1977), pp. 15-17.

The following studies are written in lay language and provide considerable information on doing an export base study, defining sources of data, and using the product:

Making Sense Out of Dollars: Economic Analysis for Local Government. Chapter 1, by Eva C. Galambos and Arthur F. Schreiber (1978). Available from:

National League of Cities  
1620 Eye Street, NW.  
Washington, D.C. 20006

The Community Economic Base Study, by Charles M. Tiebout, New York: Committee for Economic Development, Supplementary Paper No. 16, New York, 1962.

Socioeconomic Impacts of Western Energy Resource Development. Vol. I (Draft January 1979). Available from:

Denver Research Institute  
Industrial Economic Division  
University of Denver  
Denver, Colorado 80210  
(Contact: Diane Hammond, 302/753-3671)

B. Input-Output Models: A General Description. Input-output analysis is based on the interrelationships of firms both as purchasers of inputs and producers of outputs. This approach allows for the tracing of multiplier effects associated with new industry development in a more detailed manner than export base multipliers.

The interrelationships among industries in the I-O framework is expressed in terms of a matrix, called a transactions table, which indicates dollar flows from producing sectors to consuming sectors for both interindustry and final use. In figure 5, an illustrated example of a transactions table is provided.

- o Quadrant I (final demand) contains all exogenous\* sectors of the model and is made up of household expenditures, exports, capital expenditures, etc.

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Exogenous variables are those elements in the model that must be specified independently. Endogenous variables are those elements in the model whose values are determined by the model, i.e., the dependent variables.



		Agriculture	Mining	Manufacturing	Trade	Services	Finance	Household consumption	Government expenditure	Gross domestic capital formation	
		Quadrant II Intermediate production and consumption						Quadrant I Final outputs of producing sectors			
Agriculture	1	$x_{11} \dots x_{1j} \dots x_{1n}$						$C_1$	$G_1$	$I_1$	$E_1$
	.	.				.		.	.	.	.
Mining	.	.				.		.	.	.	.
	.	.				.		.	.	.	.
Manufacturing	.	.				.		.	.	.	.
	.	.				.		.	.	.	.
Trade	i	$x_{i1} \dots x_{ij} \dots x_{in}$				.		$C_i$	$G_i$	$I_i$	$E_i$
	.	.				.		.	.	.	.
Services	.	.				.		.	.	.	.
	.	.				.		.	.	.	.
Finance	n	$x_{n1} \dots x_{nj} \dots x_{nn}$				.		$C_n$	$G_n$	$I_n$	$E_n$
		Quadrant III Primary inputs to production						Quadrant IV Primary inputs to final demand			
Payments to											
Households		$H_1 \dots H_j \dots H_n$						$H_C$	$H_G$	$H_I$	$H_E$
Government		$T_1 \dots T_j \dots T_n$						$T_C$	$T_G$	$T_I$	$T_E$
Depreciation		$D_1 \dots D_j \dots T_n$						$D_C$	$D_G$	$D_I$	$D_E$
Imports		$M_1 \dots M_j \dots M_n$						$M_C$	$M_G$	$M_I$	$M_E$
gross outlays		$X_1$	$X_j$			$X_n$		$C$	$G$	$I$	$E$

Palmer, et al. "I-O Concepts" in Regional Development and Planning, USDA Economics, Statistics and Cooperatives Administration, Agriculture Handbook No. 530, May 1978, p. 24.

represent the value of output purchased from the processing sectors. A change in the level of final demand is the action which determines the multiplier estimation.

- o Quadrant II (processing sectors) contains those sectors (or sub-sectors) producing goods and services for final demand. These are the primary sectors of the model. All output of the processing sectors is sold to final demand or to other processing sectors.
- o Quadrant III (payments sectors) accounts for primary and exogenous inputs purchased by the processing sectors. It shows purchases by the processing sectors for inputs they do not produce. Entries in Quadrant III include payments to households in the form of wages, salaries, and rental income, interest income, and profits; payments to government for imports of goods and services; inventory depletion; and capital consumption or depreciation.
- o Quadrant IV shows the direct transactions between the exogenous primary input sectors (payments sectors) and the final demand. This includes outputs of the local economy as well as imports purchased directly into final use without any intermediate processing by the endogenous sectors (for example, services of household employees, labor commuting out of the area for work, intergovernmental transfers, direct household purchases of nonlocal goods, etc.).

The columns of the transactions represent the producing sectors. The cell element of any column in the table indicates the dollar amount of output a consuming industry makes from a producing industry. Alternatively, the cell element of any row in the table indicates the dollar amount of sales from a producing industry to a consuming industry.

The transactions table can be expressed by the following system of equations:

$$(1) \quad X_i = \sum_{j=1}^n x_{ij} + Y_i \quad \text{where } i, j = 1, 2, \dots, n$$

$j=1$                        $n$  = number of industries in the economy

$X_i$  = total output in industry  $i$

---

\*Exogenous variables are those elements in the model that must be specified independently. Endogenous variables are those elements in the model whose value is determined by the model, i.e., the dependent variables.

technical coefficients expresses each cell element in the first transaction table as:

$$(2) \quad \frac{x_{ij}}{x_j} = a_{ij} \quad i, j = 1, 2, \dots, n$$

where  $x_{ij}$  = sales by sector  $i$  to sector  $j$

$x_j$  = total purchases (or gross outlays) of sector  $j$ .

$a_{ij}$  = technical coefficient, or the proportion of total purchases of product  $j$  that is accounted for by the cost of product  $i$ .

The technical coefficients table, usually referred to as the input-output table, indicates the interindustry linkages among industries in a given economy. It can be used as a basis for estimating the total multiplier (direct and indirect) of an exogenous change in sales to final demand. For example, suppose that exports from the agriculture sector increase by 100 cents. The technical coefficients table tells you how much the agriculture sector must purchase from other industrial sectors in order to produce that additional sales to final demand. Let us assume that the agriculture sector must purchase 28 cents of output from itself, 11 cents output from the manufacturing sector and 17 cents output from the services sector. In the first round transactions (i.e., the "direct effects"), because the agriculture sector has to sell 28 cents to itself it must again purchase 8 cents more from itself (.28 times .28), 3 cents (.28 times .11) from manufacturing and 4.8 cents (.28 times .17) from services. Furthermore, the manufacturing and service sectors to sell to agriculture, they must purchase inputs from other sectors, as indicated in the technical coefficients table. The process continues until, ultimately, the total amount each sector must purchase required to produce is calculated. This process is the source of the multiplier.

Matrix algebra provides a much simpler method to determine the total multiplier plus indirect requirements resulting from a final demand change like the one described above. Equation (1) above can be expressed in terms of matrix algebra as follows:

A = the technical coefficients matrix  
Y = the vector of final demand

equation (4) can be reduced to:

$$(5) \quad (I-A)X = Y \quad \text{where } I = \text{the identity matrix}$$

To develop a solution, both sides of (5) are multiplied by  $(I-A)^{-1}$ :

$$(6) \quad (I-A)^{-1} (I-A)X = (I-A)^{-1} Y$$

which reduces to:

$$(7) \quad X = (I-A)^{-1} Y$$

Equation (7) is the mechanism through which I-O multiplier effects are defined. For example, if an economy's exports change due to some exogenous factor, the effect on total output (X) would be given through the  $(I-A)^{-1}$  matrix, the matrix of interdependence (i.e., direct and indirect) coefficients. There are three general types of multipliers calculated via equation (7).

The first type measures gross output or sales, and is usually referred to as the final demand multiplier. This multiplier measures the total output (direct and indirect) required of the economy to support a \$1 change in final demand in a sector.\* It is derived from an I-O model by summing the interdependence coefficients in columns of the inverse matrix  $(I-A)^{-1}$ . The sum of a column is the output multiplier for the sector named at the head of the column.

The second type of multiplier measures the total employment generated by a change in final demand for a particular sector. The basic assumption underlying the employment multipliers is that, for each endogenous sector, a linear relationship exists between employment and output. The most common I-O multipliers are the Type I and Type II.

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Part I, section K(2) for a brief discussion of how the final demand by a sector is determined.

The direct employment coefficient is obtained for each sector of the by dividing total sector employment by total sector output. The direct employment effects are estimated for each sector by multiplying the inverse matrix, with households exogenous, by a row vector of direct employment coefficients (which is merely a matrix of ratios of employment to output for each sector in the model), and summing the products for each sector (column) in the inverse matrix. Direct, indirect, and induced employment effects are estimated by multiplying the inverse matrix, with households endogenous, by a row vector of direct employment coefficients, and summing the products for each sector in the inverse matrix.\*

The direct employment coefficient of a sector multiplied by that sector's change in final demand provides an estimate of direct employment effects resulting from the final demand change. This estimate multiplied by that sector's employment multiplier equals total estimated employment changes resulting from the given change in final demand.

The third type of multiplier is the income multiplier, which measures the total change in personal income resulting from a \$1 change in income in a sector in response to a final demand change. There are Type I and Type II income multipliers, which are similar to Type I and Type II employment multipliers.

Direct income coefficients for each sector are found in the household row of the technical coefficients matrix, where households are endogenous to the household row of the payments sector, where households are exogenous to the household row of the payments sector.

To compute the direct and indirect income effects of a sector (Type I multiplier), each column entry for that sector in the interdependence coefficients (inverse) matrix is multiplied by the corresponding household row entry in the direct income coefficients vector. This multiplication is carried out for each sector in the model.

---

Households are "endogenous" when they are treated as another industry in the model (i.e., they appear in Quadrant II of the transactions table). Households are "exogenous" when they are treated as primary inputs (i.e., payments) to the model in Quadrant III.

thresholds endogenous). The household row of the new matrix yields the direct and induced income effects for each column sector.

Although the I-O analysis can provide considerable insight into the structure and interaction among sectors of an economy, the approach has several limitations. First, the assumption of constant production coefficients (inputs per unit of output) implies that a doubling of inputs will lead to a doubling of output. Under this assumption, economies of scale are effectively ruled out. Innovations and changes in production techniques are also unaccounted for. This omission may be particularly important for newer industries, such as solar energy or microelectronics, which are expected to automate and innovate significantly as they develop. The seriousness of the problem will vary with the length of the forecast period.

The assumption of constant coefficients is also inaccurate in cases where agglomeration and urbanization economies develop. The former arise when many plants in the same industry locate in close proximity to each other. External economies accrue to individual firms since many ancillary firms will locate around such an agglomeration and provide specialized services at lower costs. Urbanization economies occur when firms in different industries locate in close proximity to each other and a corresponding infrastructure develops to service them.

Similar limitations apply to the use of direct employment coefficients. These coefficients are based on the assumption of relatively full utilization of currently employed labor. If a sector was known to have significant underemployment at the time of the development of the basic model, use of the direct employment coefficients is likely to overstate the direct employment effect and depressed output. In such instances, the direct coefficients should be adjusted to reflect the changes in labor productivity that occur when labor becomes fully employed.\*

Although this conceptual limitation is significant, it is not insurmountable. Several methods can be used to adjust the input-output coefficients to take account of technological and productivity changes. The first involves adjusting

Methods for correcting these and other estimation errors in I-O are described in:

Net Energy Analysis: Handbook for Combining Process and Input-Output Analysis. Clark Bullard, Peter Penner and David Pilati, Center for Advanced Computation, University of Illinois, Urbana, Illinois (1976), CAC Doc. No. 214. Price: \$5.

The static I-O analysis also assumes that both supply and demand are completely elastic. This implies that additional inputs are forthcoming at a constant price and that any quantity of product can be sold without effect on price. Although there are some methods available to estimate the potential output of a resource constrained sector,\*\* it is very difficult to incorporate dynamic aspects into traditional I-O analyses.

#### References:

Three reports, available free of charge, provide a step-by-step description of the I-O methodology and its application:

The Use of Input-Output Analysis. Regional Development and Planning. U.S. Department of Agriculture, Economics, Statistics and Cooperative Service. Agriculture Handbook No. 530.

Input-Output Analysis Applied to Rural Resource Development Planning. Clifford D. Jones, Jr. U.S. Department of Agriculture, Economics, Statistics and Cooperative Service. ESCS-14.

National Income and Product, Input-Output, and Employment Analysis. E. Kutscher. Office of Economic Growth, Bureau of Labor Statistics, U.S. Department of Commerce.

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See: The American Economy to 1985, C. Almon, Jr., New York: Harper & Row, 1966; and Bureau of Reclamation Economic Assessment Model: Technical Report, U.S. Department of Interior, January 1978, p. 23.

See: The Use of Input-Output Analysis, Regional Development and Planning, U.S. Department of Agriculture, Agriculture Handbook No. 530, p. 62.

these were then converted to employment. See:

Fiscal Impact of a New Industry in a Rural Area: A Coal Gasification Plant in Western North Dakota, in: Regional Science Perspectives, 1976 (published by the Mid-Continent Regional Science Association). Reprints are available, free of charge, from the Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota 58105.

Detailed bibliography on I-O analysis is presented in appendix D.

The following section provides a list of export base and I-O models that can be used to determine indirect/induced employment and earnings differences and costs of this type of information is presented. Those models that have already been described in the previous section will be referred to briefly here.

C. Export Base Models. There are two easily accessible export base models that can be used to determine the "non-basic" employment and earnings associated with energy development. These are the Argonne SEAM model (described briefly in part I) and the Bureau of Reclamation Economic Assessment Model (SEAM).

(1). SEAM. The SEAM model determines a simple ratio, complex ratio, or a ratio computed by regression analysis for the counties studied. Regression coefficient multipliers were derived from the following estimation:

$$S = \frac{M}{AM} + B_1 \frac{AM}{FC} + B_2 \frac{FC}{T}$$

where S = number employed in service (or "non-basic" industries)  
AM = combined number working in agriculture or mining  
FC = manufacturing and construction employment  
T = transportation employment

In addition, the equation includes control variables (e.g., number of families below poverty, average family income, etc.) when significant. It should be reminded that the regression coefficient multipliers B<sub>1</sub>, B<sub>2</sub> and B<sub>3</sub> must be increased by 1 to be comparable to the ratio multipliers.

The product of the chosen Argonne employment multiplier and the change in construction or operation jobs associated with an energy project in a given county yields the total employment effects. In addition, the Argonne model provides



year 1, 71 percent; year 2, 17 percent; year 3, 8 percent; year 4, 4

The Argonne multipliers and lag factors are presented and described in:

A Framework for Projecting Employment and Population Changes Associated with

Energy Development: Phase 1. Erik J. Stenehjem and James G. M. Argonne National Laboratories, August 1976.

Cost: \$0.

For an excellent, well-written description of how to use SEAM multipliers to assess the economic effects of nuclear powerplant construction in a region, see:

An Economic Impact Analysis of Energy Facilities with Particular Reference to the Hartsville, Tennessee Area (Preliminary Report) by Walter Thomas A. Reiner and Roger Van Zele, Oak Ridge National Laboratory, Oak Ridge, Tennessee ORNL/TM-6627 (May 1979).

Available from NITS, U.S. Department of Commerce, 5825 Port Royal Road, Springfield, Virginia 22161. Price: Printed copy \$4.50; microfilm \$3.00.

An official procedure for public use of SEAM has not yet been established. Direct all requests to Erik Stenehjem, Roger Shull or Ron Matheny (see section K(1a) for their addresses and phone numbers).

(2). BREAM. The BREAM model can be used to determine the total employment and income effects associated with a new energy facility on the county level. Unlike the SEAM model, however, the user must specify the direct (or primary) employment associated with the energy facility; BREAM then estimates the secondary effects, using export base theory. The model is organized into the following submodels:

- o Demographic Submodel, a cohort-survival model which analyzes the effects of natality, mortality and migration on all major population subgroups and projections of the local area to make county specific population projections;
- o Economic Submodel, an export-base model which determines the employment and total personal income associated with the economic activity. First, basic labor income is derived from the

sum of basic labor income, non-basic labor income, and non-labor income (i.e., including transfer payments, dividends, interest, rent, and excluding social security payments). Non-labor income is partly endogenous, and partly determined outside the model.

- o Labor Market Submodel, which evaluates the consistency of the output from the demographic submodel with that from the economic submodel; i.e., is the number of jobs roughly equal to the number of persons willing and able to assume jobs. If there is an excess of jobs relative to the size of the labor force, it is assumed that balance will be reestablished between the supply and demand for labor by immigration. If, on the other hand, there is excess supply of labor, it is assumed that outmigration will occur. Whenever migration occurs, it is necessary to iterate back through the demographic submodel so that the county population can be appropriately adjusted.\*\*
- o Community Allocation Submodel, which allocates the population determined in the demographic submodel to communities within each county.

SEAM approach has a major advantage over SEAM and other traditional models: it adds an income sector to the estimation process that allocates jobs according to earnings per employee differentials. In this analysis can differentiate among energy facilities with different wages.

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Economic submodel includes the following BEA industry sectors: farm (farmers, laborers), mining, contract construction, manufacturing, transportation/communication/public utilities, wholesale and retail trade, finance/real estate, services, government and other (non-farm proprietors).

Model also includes a construction worker submodel. This submodel estimates the local/non-local mix of construction workers, estimates the demographics of immigrating workers and their families, and allocates them within the county.

- o For the Demographic Submodel:
  - Total births by county by year;
  - Total population by community for 1970 and first forecast period;
  - Death or survival rates by age and sex;
  - Fertility rates by age of mother;
  - Educational outmigration rates by age and sex by county;
  - Nonresident college population by county;
  - Age distribution for retirement by county;
  - Retirement migration.
- o Construction Worker Submodel:
  - Project employment by year;
  - Proportion of nonlocal construction married but without families;
  - Average number of nonlocal construction workers per housing unit;
  - Indirect purchases of locally produced goods or services.
- o Labor Market Submodel:
  - Total labor force by county;
  - Total employment by county;
  - Labor force participation rates by age and sex and by county.
- o Community Allocation Model:
  - Average number of persons per household by county;
  - Average household size for person 60 years of age and over;
  - Change in average household size;
  - Project to community distances.

The estimated time for collecting this data initially is about 100 hours. The work can be done by graduate students (@ \$6/hr.), for about \$480-\$600. This process will become shorter and less costly as it becomes internalized in the model over the next year.

odel has not yet been established. All requests should be directed to

Randy Threadgill  
Bureau of Reclamation  
Denver Federal Center  
Denver, Colorado  
303/234-3166

The BREAM approach is also available in a model developed by the S  
rizona.\*\* The Arizona Economic Demographic Projection Model (EDPM) ma  
employment and income projections to 2000 for all counties in Arizona.  
f running the model is \$50-\$75 per run (staff and computer time). The  
un for Arizona is already on file. The model could be purchased and a  
ther states. However, because of the limited documentation of EDPM, p  
users are advised to use BREAM for regions other than Arizona. Contact

Bryan Meincke  
Department of Economic Security  
Office of Planning (0452)  
P.O. Box 6123  
Phoenix, Arizona 85007

References (free of charge):

Bureau of Reclamation Economic Assessment Model (BREAM) Technical Description. Bureau of Reclamation, Engineering and Research Center, Denver, Colorado 80225. Prepared by: Mountain West Research, Inc Temple, Arizona. January 1978.

Economic/Demographic Assessment Manual. Bureau of Reclamation. Engineering and Research Center, Denver Federal Center, Denver, CO 80225. Attention: 922.

The Arizona Economic Demographic Projection Model (EDPM). E. J. A T. L. Beckhelm and W. M. Hannigan. Office of Economic Planning and Development, Phoenix, Arizona (1977).

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Submodels cannot be run separately.

\*EDPM was, in fact, the forerunner of BREAM.

relies heavily on data input by the user which, in this case, is primarily Utah-specific. Hence, UPED is not readily adaptable for projections other than in Utah. For more information, contact the Office of the State Coordinator (Salt Lake City, Utah).

D. Input-Output Models. Several I-O models are available for determining the indirect/induced employment and earnings effects associated with energy development. These are:

(1). The Bureau of Labor Statistics Input-Output Model (BLS/I-O) described in part 1 of this section, can be used to determine total earnings and output associated with alternative energy scenarios.

#### Availability and Cost of Information:

- o Input-Output Matrix. Data from 129 industries for 1976, 1980, and 1990 (projected) include: Input-output coefficient matrices; final demand and components; civilian employment; and wage and employment and output series by industry with additional annual data for 1958-74. Cost: \$100.\*

For users without access to computer facilities, the Office of Economic Growth has done some contract work to run the BLS model and provide analysis of the output. The cost depends on the task. For further information, contact:

Charles Bowman/Ken Rogers (202/523-9036)  
Office of Economic Growth  
Bureau of Labor Statistics  
U.S. Department of Labor  
Washington, D.C. 20212

#### References (with Applications to Energy/Employment issues):

An Analysis of the Macroeconomic Effects of Industrial Cogeneration Development Using Input/Output Techniques and the DRI Quarterly Macroeconomic Model. September 1978. JRB Associates, Inc., 8000 Drive, McLean, Virginia 22102. Contact:

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\*Note: This is the same tape used for obtaining employment and earnings ratios. See part 1, section K(2d).

Employment Analysis of Alternative Energy Scenarios. U.S.  
Department of Energy. Energy Information Administration (August 1978).  
Contact: Ron Earley 202/633-2693.)

Economic and Sector Implication of Installing 2.2 Million Residential  
Units (Draft) Energy Information Administration (December 1978).  
Contact: Ron Earley.

The Brookhaven I-O/BESOM system can be used to evaluate the direct  
employment effects of alternate energy scenarios on a national  
energy system can be segmented into three separate models: (1) BESOM is a  
programming model of the energy sector; (2) the BNL I-O model is a IIO  
model\* of the national economy; and (3) the linked BNL/BESOM model,  
links energy and nonenergy sectors to evaluate alternative scenarios.  
These models is described briefly below.

o BESOM can determine the minimum cost allocation of energy supplies  
to meet energy demands. BESOM can also be used to determine some  
of the cost and economic impacts of specific demand/supply config-  
urations. The user specifies a set of energy requirements defined  
by end-uses, a set of available energy resources and conversion  
technologies and costs. The eight end-product energy sectors in  
the model include:

ore reduction feedstock	process heat
chemical feedstocks	water heat
motive power	space heat
air conditioning	electric power

The 12 energy supply/conversion sectors in the BESOM model  
currently include:

coal	refined oil products
crude oil and gas	pipeline gas
shale oil	coal combined-cycle
methane from coal	electric

sectors, see attachment to table C-4, in appendix C.

- o BNL I-O model has 110 sectors with "A" matrix coefficients and final demand, total output, employment and earnings vectors forecasted for 1985. Several distinguishing characteristics of the BNL I-O model differentiate it from conventional interindust I-O models:

- The BNL model is composed of energy and nonenergy sectors with the output of the energy sectors expressed in terms of physical Btu units (the nonenergy sector is expressed in constant dollars).

- Outputs of the energy supply/conversion sectors are distributed to energy product sectors instead of directly to consuming sectors. The supply sectors convert and distribute raw fuels sectors producing traditional energy forms. The outputs of these supply/ conversion sectors are then distributed to energy end-product sectors. (See table C-4 and attachment.)

The "A" matrix for the BNL I-O model has the following form:

		<u>S</u>	<u>P</u>	<u>I</u>
Energy Supply/Conversion	S	$A_{SS}$	$A_{SP}$	0
Energy Products	P	$A_{PS}$	0	$A_{PI}$
Nonenergy Sectors	I	$A_{IS}$	0	$A_{II}$

where:

$A_{SS}$  = input-output coefficients describing sales of the output of one energy/supply conversion sector to another energy conversion sector and conversion losses incurred in producing or distributing energy.

producing sectors; energy products are used by the nonenergy producing sectors.

$A_{PS}$  = input-output coefficients describing how energy products--final energy forms--are used by the energy-supplying industries. Included here would be electricity use for lighting a refinery.

$A_{PP}$  = 0 implying that energy products are not used to produce energy products.

$A_{PI}$  = input-output coefficients describing how energy products--final energy forms--are used by nonenergy-producing sectors. This submatrix describes the ways end-use energy forms are used in the nonenergy-producing sectors. Examples are blast furnace heating or space heating.

$A_{IS}$  = input-output coefficients describing the uses of nonenergy materials and services by the energy industry such as pipes and pumps.

$A_{IP}$  = 0 implying energy product-sectors equipment require no material or service inputs. This is because they are pseudo-sectors and not real producing sectors.

$A_{II}$  = input-output coefficients describing how nonenergy products are used in the nonenergy-producing sector. An example would be steel for golf clubs.

structure, which allows the specification of transactions in terms of final use, has certain important advantages:

Conservation owing to technical improvements or reductions in consumer demand may be implemented by modifying the  $A_{PI}$  coefficients or final demands for energy products. This is more direct and realistic than modeling reductions in the demand for energy products by reducing the sales of several primary or secondary energy sectors as would be required in a conventional input-output model.



- o The BNL/BESOM linked models provide for the endogenous estimation of the Ass, Asp, derived from the BESOM solution output. Likewise the linked version allows interindustry demands for energy production of those variables that are required for GNP determination must be specified exogenously. These variables (personal consumption, etc.) can be determined by linking the BNL/BESOM model with the Long-Term Interindustry model or the Hudson-Jorgenson Long-Term Interindustry Transactions model (H-J).\*

Brookhaven National Laboratories is in the process of incorporating the SERI data base for 16 solar technologies in the BNL/BESOM system (part 1, section G). This work will be completed by late summer 1979.

#### Cost and Availability of Information:

As in the case of the BLS I-O model, data tapes for the BNL I-O/BESOM model are readily available to the user with computer facilities. Brookhaven has made arrangements for users outside of the Federal Government to buy computer time off BNL computers. However, it is virtually impossible for a non-Federal Government user to purchase staff/analyst time from the National Laboratory. The fee structure for data tapes and computer time are:\*\*

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\*For a description of these long-term models and their applications see: Estimation of the Short-Term Macroeconomic Impacts of Energy Price Changes on the U.S. Economy, (appendix A), JRB Associates, Inc., McLean, Virginia (1978); A Comparative Assessment of Energy-Economy Interactions: Price Effects on Growth, (DRAFT: January 1979) Richard Goettle, Edward Hudson, Joan Hudson, Brookhaven National Laboratory; and Energy Conservation Policies, Economic Mechanisms, and Impacts, (December 1978), Edward Hudson and David E. Hudson, Brookhaven National Laboratory.

\*\*See part 1, section K(2a) for the free information available on energy employment and occupational mix from the BNL model.

ESOM	free	\$200
NL I-0	free	\$100
ESOM/BNL I-0	free	\$300
RI/BNL I-0	free	\$200

OTE: The combined BNL I-0 and Hudson-Jorgenson (H-J) macroeconomic model is not available through Brookhaven to outside users since the H-J model is proprietary.

#### References:

Documentation of the Brookhaven Energy I-0 and I-0/BESOM Linkage Model. Fraser. Brookhaven National Laboratory (August 1978).

Brookhaven Energy System Optimization Model Methodology and Documentation (Version 2.1). Cherniavsky, Juang, Kydes and Rabinowitz. Brookhaven National Laboratory (February 1978).

Applications of the model to energy issues:

An Energy and Economic Evaluation of Policies for Accelerated Introduction of Efficient Automobiles. Walter Brooks, Steven Carhart, Gordon M. Shirish S. Mulherkar. Brookhaven National Laboratory (August 1978). Preliminary Report.

Energy Employment, and Environmental Impacts of Accelerated Investment in Conservation and Solar Technologies in Buildings. Steven Carhart, Shirish Mulherkar, Jay Schwam. Brookhaven National Laboratory (August 1978). Preliminary Report.

A Comparative Assessment of Energy-Economy Interactions: Price Elasticities and Growth. Richard Goettle, Edward Hudson, Joan Lukachinski. Brookhaven National Laboratory (January 1979). Draft.

#### Personal Contacts:

Dick Goettle  
Dale Jorgenson Associates  
Department of Economics  
Harvard University  
122 Littauer Center  
Cambridge, Massachusetts 02138

(subsequently revised) from data obtained by personal interview. The model cost approximately \$250,000 to develop. Description of the methodology (including sample interviews) and potential applications is available in:

Stimulating Regional Economic Development. William Miernyk et al. (Heath, Lexington Books, 1970).

The model includes sectors for two types of coal mining (underground; strip and augur), for petroleum and natural gas, for electric and gas power systems. The model is on computer and is available for less than approximately \$100. Contact:

James Maddy  
Governors Office of Economic  
and Community Development  
R151 State Capitol  
Charleston, West Virginia 25305

- o Georgia. The Department of Industry and Trade financed the development of a survey-based (for manufacturing sectors) I-O. The 1970 model is available for 367-sector, 50-sector, and 30-sector aggregations corresponding to the national BEA model. The model cost about \$80,000 to develop in 1971. Description of the model and applications is available in:

Using the Georgia Economic Model. William Schaffer, Laurent, Ernest Sutter, Jr., Office of Planning and Development, State of Georgia. 1972.

The model includes individual sectors for petroleum products and utilities. It is available for use for less than \$1,000. Contact:

Dr. William A. Schaffer  
College of Industrial Management  
Georgia Tech  
Atlanta, Georgia 30332  
404/894-2600

which enables it to be used for projections to 1985 and 1990. The model cost approximately \$200,000 to develop (\$125,000 for the model; \$75,000 for the econometric "linkage"). A description of the model and its potential applications is available in:

The 1972 Washington Input-Output Study, by Phillip J. Bourque and Edward J. Chambers, Seattle, Washington: The Graduate School of Business Administration, University of Washington. June 1977.

The Washington Projection and Simulation Model. Phillip J. Bourque and Edward J. Chambers, University of Washington. September 1977.

The Input-Output Structure of Washington State, Phillip J. Bourque, Richard S. Conway, Jr., University of Washington. February 1976.

The model includes sectors for petroleum refining, natural gas, electricity and mining. The cost of using the model depends on the task. Contact:

Phillip J. Bourque  
Graduate School of Business Administration  
University of Washington  
Seattle, Washington  
206/543-4484

An inventory of regional and state input-output models and documentation is available in:

Regional and Interregional Input-Output Analysis: An Annotated Bibliography, by Frank Giarratani, James D. Maddy and Charles Socher, West Virginia University Library. 1976.

An Inventory of Regional Input-Output Studies in the United States, Occasional Paper No. 22 by Phillip J. Bourque and Millicent Coates, Graduate School of Business Administration, University of Washington. Seattle, Washington. 1970.

Non-survey models adapt survey-based national or regional models to economy through the use of secondary data sources (e.g., U.S. Census employment departments).<sup>\*</sup> Any primary data that the researcher can low cost is also used in this estimation.

On balance, the non-survey approach to estimating regional I-O represents a relatively cost-effective means for performing regional. It is no doubt less accurate than survey-based methods, but it is less expensive to develop. Non-survey models are more accurate when evaluate exogenously generated impacts than for "structural" changes "forecasts". But, in any case, diminishing returns set in rapidly in data collection for the construction of an I-O model for a particular. Three non-survey regional I-O models are described in this report: Industrial Multiplier System (RIMS)\*\*, the Regional Science Research Model (RSRI) and the Lawrence Berkeley Laboratory Model (LBL). The described in a later section due to the relatively high costs involved in development and use. The RSRI and RIMS models are described below.

(4a). The Regional Science Research Institute Model (RSRI) provides detailed estimates of regional impacts which result from the direct stimulus provided by, for example, construction and operation of a new or in the contraction of such an activity. The specific impacts that are estimated are:

- o Economic activity, by industry;
- o Wage and salary income, by industry;
- o Employment, by industry;
- o Employment, by occupation;

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<sup>\*</sup>See, for example: The Use of Input-Output Analysis, Appendix B, U.S. Department of Agriculture, Economics, Statistics and Cooperative Service, Agriculture Handbook No. 530.

<sup>\*\*</sup>See also part 1, section K(2b).

Emissions to water, by industry and type of emission.

al specifies 490 industry sectors (including separate sectors for steam engine manufacturing, electric companies and systems, gas es and systems, crude petroleum and gas) and 232 occupational categories (table C-8 in appendix C). The model can be adapted to any state, metropolitan area, or other grouping of contiguous counties, and can be modified to provide estimates for the subregions which constitute a region as well as for the region as a whole. A typical adaptation costs in the neighborhood of \$10,000, but it could be significantly more depending on data problems, the number of subregional models, the addition of submodels for energy use, air pollution, generation, emissions to air, emissions to water, extra help in setting up the model on a client's system, etc.

RSRI has adapted their model to several substate regions, including the Philadelphia SMSA, the Richmond, Virginia Planning District, the Baltimore-Washington area, and the New York-New Jersey metropolitan region. Once the model is adapted to RSRI of maintaining and running it are relatively low. A typical example of the prices charged by RSRI for simple analyses using an already developed regional model is presented below:

RSRI Billing Fees for Standard\*  
Regional Input-Output Runs Done at One Time

<u>Number of Runs</u>	<u>Total Fee</u>
1	\$ 500
2	700
3	900
4	1,050
5	1,200
6	1,350

In addition to this detailed, regional I-O effort, RSRI has also developed a simplified I-O model which is linked to an econometric description of basic

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...ance to final demand expressed as outputs of one or more four-digit SIC (1967 SIC definition).

Additional information on the RSRI Regional Models can be obtained

Dr. Benjamin H. Stevens  
President  
Regional Science Research Institute  
Wentworth Building  
256 North Pleasant Street  
Amherst, Massachusetts 01002  
(Telephone: 413/256-8526)

Dr. Robert E. Coughlin  
Vice President  
Regional Science Research Institute  
P.O. Box 8776  
Philadelphia, Pennsylvania 19101  
(Telephone: 215/222-3940)

### References:

Richmond Input-Output Study: Volume II, Construction of the Model  
by Gene Steiker et al. RSRI, P.O. Box 8776, Philadelphia, Pennsylvania  
19101 (August 1976).

Regional Economic Impact from Construction of a Nuclear Electric  
Plant, by Gene Steiker and James Strathman. RSRI Discussion Paper  
No. 91 (December 1976). This paper uses the Philadelphia SMSA

The Employment Sector of a Regional Policy Simulation Model, by  
Treyz et al. RSRI Discussion Paper Series: No. 107 (November 1976)

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\*The "core" program described here is modeled after the Massachusetts  
Policy Analysis Model (MEPA), which includes the relationships that  
models and also allows for substitution among factors of production  
relative factor costs. MEPA cost \$200,000-\$300,000 to develop. To  
arrangements for its use have been limited to state agencies and the  
(for a subscriber fee of about \$5,000). For more information on MEPA  
applications, contact: George Treyz, Economic Department, University of  
Massachusetts, Amherst, MA. (413) 545-0915/2590.

(4b). The Regional Industrial Multiplier Systems (RIMS), as described in section K(2b), can be used to determine the direct and secondary employment and earnings effects of energy choices on a regional level.

Availability and Cost of Information:

Multipliers for selected areas are available without charge from two sets. One set is estimated by BEA economic area (see figure 3 in section I) for 56 industries aggregated from the basic 484 national model industries. A second set is estimated, by state, for a 103-industry aggregation.

Contact: Joseph Cartwright (202/523-0594)  
Regional Economic Analysis Division  
Bureau of Economic Analysis, BE-61  
Department of Commerce  
Washington, D.C. 20230

Industry-specific multipliers are available from BEA for any region composed of one or more counties and for any of 484 industries. Results are reported in tabular form similar to the example in exhibit 2. Factors for converting a gross-output change to a change in earnings and employment are also provided.\*

Cost: \$1,000 for each region. The user need only define the region in terms of counties.

Contact: Joseph Cartwright (see above)

Specifically tailored quick-response packages can also be developed through BEA contract arrangements, that will address analytical needs not covered by the standard output of the system.

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Another option available to the user (at additional cost) is the aggregation of sectors in the national I-O model.



Energy Information Administration  
National Energy Information Center  
Office of Energy Information Services  
Attention: Heidi Sanford (202/634-5610)  
Room 230  
1726 M Street, NW.  
Washington, D.C. 10461

The data is available on 8 files:

- File 1:     Census-Region Multipliers and Components. This file contains 16 sector industrial output multipliers and components for each census region.
- File 2:     Multi-Region Multipliers and Components. This file contains 103 sector industrial output multipliers and components for each state and census region.
- File 3:     Census Region Direct Coefficients. This file contains direct coefficient estimates for 16 sectors in each census region.
- File 4:     Multi-Region Direct Coefficients. This file contains direct coefficients for 103 sectors in each state and census region.
- File 5&6:   Industry Earnings--Gross Output Ratios. This file contains industry earnings--gross output ratios for states and census regions (in 1967 dollars).
- File 7:     Industry Employment-Earnings Ratios. This file contains industry employment-earnings ratios in the form of estimates (weighted averages in 1967 dollars).
- File 8:     Inverse Matrices. This file contains the inverse matrices (103 sector) for states and census regions.

System Name: Preliminary READ Model Data Base.

## Elements of

IC	Industry Name	Indirect-			Total
		Direct Component	Induced Component	Multiplier	
1	Farms	.0934	.0941	.1875	
7	Agricultural services	.0000	.0092	.0092	
1	Coal mining	.0000	.0006	.0008	
4	Nonmetallic mineral mining and quarrying	.0000	.0005	.0005	
5-17	Contract construction	.0027	.0063	.0090	
0	Food and kindred products	.2851	.0618	1.3469	
2	Textile mill products	.0000	.0133	.0133	
3	Apparel and other fabricated textile products	.0002	.0112	.0114	
4	Lumber and wood products, except furniture	.0000	.0035	.0035	
5	Furniture and fixtures	.0000	.0008	.0008	
6	Paper and allied products	.0536	.0064	.0600	
7	Printing, publishing and allied products	.0000	.0023	.0023	
8	Chemicals and allied products	.0000	.0015	.0015	
9	Petroleum and related industries	.0019	.0041	.0060	
0	Rubber and miscellaneous plastic products	.0001	.0001	.0002	
1	Leather and leather products	.0000	.0053	.0053	
2	Stone, clay and glass products	.0000	.0007	.0007	
3	Primary metals industries	.0000	.0017	.0017	
4	Fabricated metals products	.0003	.0046	.0049	
5	Machinery, except electrical	.0000	.0002	.0002	
6	Electrical machinery	.0000	.0004	.0004	
71	Motor vehicles	.0000	.0000	.0000	
72-379	Other transportation vehicles	.0000	.0001	.0001	

This exhibit includes only some of the industrial sectors in the RIMS multiplier system, and is for illustrative purposes only.

Vol = SER = FE7985, F10972.

Requests should be made in letter form, and should indicate the type of information needed (e.g., data tapes or computer printout).

Costs: for tapes: cost of blank tape for all files listed above (a \$50); for computer printouts: minimal (about \$10 to \$25)

Bureau of Economic Analysis (BEA), in conjunction with the U.S. Department of Housing and Urban Development (HUD) has recently developed RIMS multipliers for 46 construction industries in 61 SMSA economic areas. For 20 SMSA areas, BEA also disaggregated the multipliers into "core county" and "non-core county" (i.e., suburb) multipliers. BEA has put together a package of the multipliers for the 61 SMSA areas, entitled:

Regional Impact of Changes in Construction Spending: An Analysis of Multiplier Differentials (mimeo June 1979) by Joseph Cartwright, Ralph Depass, Richard Gustely, and James Younger. Regional Economic Analysis Division, Bureau of Economic Analysis, U.S. Department of Commerce

is in the process of developing a similar paper for the "core" and "non-core" multipliers associated with construction industries in the 20 SMSA areas. For more information on these multipliers, contact:

Richard Gustely (202/523-0953)  
Room 305  
1401 K. Street, NW.  
Washington, D.C. 20230

RIMS multipliers are also used as input into a local impact assessment developed by the Energy Systems Research Group, Inc. (ESRG). The ESRG has the following features:

A data base containing information on cost, labor requirements and energy savings for various residential energy technologies.

A financial package allowing the user to develop implementation rates for residential energy technologies under alternate financial assumptions. Data in technologies can come from the ESRG data base or elsewhere.

currently in progress on a commercial sector data base and a  
compute "public benefits."

prepared to run specific analyses developed by clients and/or to  
development of a client's program. For the analysis of a well-  
energy program using ESRG data, or a client's data base which is  
the cost would run about \$6,000. This includes the purchase of one  
multipliers for the region under consideration. For further  
contact:

Stutz  
gy Systems Research Group, Inc.  
Milk Street  
on, Massachusetts 02101  
) 426-5844

he INFORUM model, developed at the University of Maryland's  
y Economics Research Project, is a 200-sector national input-output  
ed to produce annual projections over a 10 to 15-year time horizon  
s the base year). The INFORUM model forecasts the sales of each of  
ors:

as material or service inputs in the production of the  
200 products;

as materials used in 30 construction activities;

as capital equipment purchases by 90 industries (which  
are aggregates of the 200 sectors);

as purchases for six categories of Government operations;

as exports (offset by imports as a negative entry);

as inventory change;

as personal consumption expenditure.

el also provides forecasts of prices and wages of the 200 sectors,  
nt in the 90 aggregate sectors. INFORUM has also been used to

Table C-9 in appendix C lists the 200 sectors in the INFORUM model. Their corresponding SIC codes. Note that the model includes separate sectors for coal mining, crude petroleum, natural gas, petroleum refining, fuel, and electric utilities.

#### Availability and Cost of Information:

The INFORUM model is available for use only to subscribers.

Cost of annual subscription: \$5,000.

Contact: Margaret Buckler/Clopper Almon  
Economics Department  
University of Maryland  
College Park, Maryland 20742  
301/454-5384

#### References:

A Brief Description of INFORUM, Interindustry Forecasting Project  
University of Maryland (November 1978).

1985: Interindustry Forecasts of the American Economy, C. Almon,  
Buckler, L. M. Horwitz, and T. C. Reimbold. Lexington, Massachusetts:  
Heath, 1974.

(6). The REAP model, as described in part 1, section K(2c), can provide information on the direct and secondary employment effects of energy demand in western North Dakota.

#### Availability and Cost of Information:

- o REAP model run for a single  
energy expansion scenario: free of charge
- o REAP model run for two  
energy scenarios: less than \$10

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See: Employment Impacts of Achieving Federal Energy Conservation Goals Pertaining to Automobile MPG Efficiency, Home Retrofitting and Industrial Energy Use for the Period 1978-1985; Douglas C. Dacy, Robert E. Kuenne and Paul A. Institute for Defense Analysis, Arlington, Virginia. IDA Paper, P-134

REAP has been made available to Texas, free of charge, for adaptation to the state's economy. Adaptation of the REAP model to Texas is expected to require 3 months of work by professionals in regional economics, 3 months of work by economic/demographic analysts, and 3 months of work by computer programmers. The estimated cost of this project is \$30,500:

Professionals:	5 months @ \$25,000/yr. =	\$10,500
Economic/demographic analysts:	8 months @ \$1,000/mo. =	8,000
Computer programmers:	6 months @ \$1,000/mo. =	<u>6,000</u>
Computer time		3,000
Travel and data collection expense		<u>3,000</u>
Total		\$30,500

Personal Contacts:

Glen D. Schaible  
Research Coordinator  
Regional Environmental Assessment Program  
Suite 521  
316 North Fifth Street  
Bismarck, North Dakota 58505  
(701/224-3700)

For information on the Texas adaptation of REAP:

Larry Leistritz (701/237-7441)  
Department of Agricultural Economics  
North Dakota State University  
Fargo, North Dakota 58105

(7). The Lawrence Berkeley Laboratory (LBL) has developed a national modeling capability to assess the direct and indirect employment effects associated with alternative energy scenarios. LBL has adapted the 1967 BEA national I-O table to 1972 and disaggregated the 7 mine

ionalize the national I-O to each state. Regional I-O tables have already been developed for the eight Rocky Mountain States and California, as described below.

Development of State Interindustry Models for Rocky Mountain States and California. Jayant Sathaye and Leonard Kunin. Energy Analysis Program. Lawrence Berkeley Laboratory. LBL-4465. February 1977. Cost \$4.50 (microfiche: \$3.00), available from:

National Technical Information Service  
U.S. Department of Commerce  
5285 Port Royal Road  
Springfield, Virginia 22161

In addition, LBL has the capability to regionalize the Bechtel ESPM model to each state. Figure 6 illustrates the general methodology linking energy supply planning models with the input-output models.

#### Availability and Cost of Information:

The cost of regionalizing the ESPM and I-O models, running the models, and analyzing the results for various energy scenarios is approximately \$1000 per state. This cost is significantly less for those states for which interindustry models and regionalized ESPM data has already been developed. These include: California, Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming.

An example of this type of analysis, performed for the State of California, is presented in:

Analysis of the California Energy Industry. Energy and Environmental Division, Lawrence Berkeley Laboratory. (January 1977).

For further information contact:

Jayant Sathaye  
Lawrence Berkeley Laboratory  
University of California  
Berkeley, California 94720  
415/451-6292

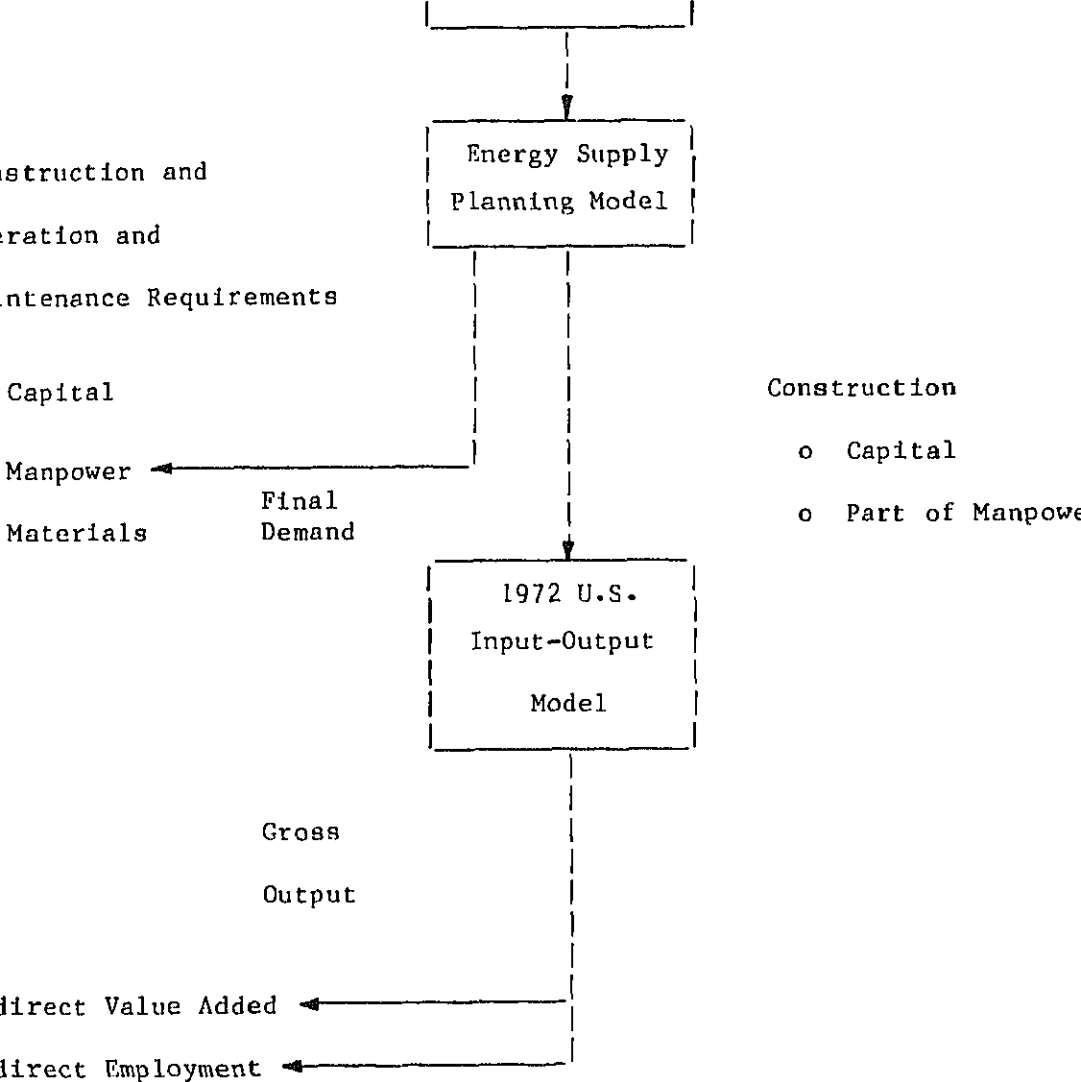


Figure 6: Analytical Methodology  
for Lawrence Berkeley  
Laboratory Model



- o The policy question requires analysis of the total net employment impact associated with each energy alternative and the job creation associated with the displaced system is realized in the local area.
- o The policy question requires a comparative analysis of net employment impacts among energy alternatives and the alternative have different total costs or they each displace different energy sources.

The sources for direct and indirect/induced employment effects 2) can be used to determine the cost and availability of information displacement effects.

Part 4. Respending/Substitution Effects. In addition to the direct and indirect/induced and displacement effects, there is another effect that arises if the energy source encouraged through policy measures incurs different costs than the next best alternative. If this energy source is less costly than the next best alternative, (and hence employment and income growth) occurs, real economic growth (and hence employment and income growth) occurs. The resource savings are "resent" on additional goods and services. For example, if an energy source that costs more per energy output than its alternative is made available to the public, can decrease overall employment and earnings by diverting spending from other (more labor intensive) sectors of the economy. The former situation is referred to as the "responding effect"; the latter is the "substitution effect." The responding/substitution effects will be estimated in almost all cases where energy alternatives have unequal costs. The major exception is when energy alternatives are compared for a very small, undiversified economy, where most of personal consumption expenditures and investment are made outside the region (see section I).

In order to estimate the responding/substitution effects associated with energy policies, it is necessary to determine:

- (1) The real resource (i.e., unsubsidized) costs of the energy source encouraged and of its competing energy source(s) over the evaluation period. The difference between these costs represents the energy cost savings/increases associated with a particular policy.
- (2) Who realizes these energy cost savings/increases--private consumers or the Government?

financed (i.e., from reductions in consumer expenditures, investment, or increased Government debt)?

- (4) What are the employment and earnings effects associated with a dollar increase/decrease in consumer expenditures, investment, or Government debt?

It should be noted that the importance of these considerations will differ significantly across regions. For example, if the subsidies to conventional energy are primarily Federally funded, then individual communities must need to factor these subsidies into their energy costs. This is because the cost of Federal subsidies is spread over the entire Nation. Any one community is only negligibly affected. On the other hand, the magnitude of these subsidies will make a difference to the Nation as a whole, or to large subnational regions. Similarly, any consideration of cost-savings and how they are spent may be more relevant to a small region (where most goods and services are imported) than to a larger, well-diversified economies, however, these considerations will be important.

Unfortunately, there are large gaps in information about the real resource costs of energy, the behavior of energy consumers facing changes in energy prices, and the effect of different types of expenditures on employment and earnings in the economy. A discussion of some of the relevant sources for these types of information is presented below.

A. Real resource costs of energy. There is very little information about the real resource cost of conventional energy sources, mainly because the cost is "hidden" by existing pricing policies and a variety of direct and indirect subsidies. A recent analysis by the Battelle Pacific Northwest Laboratory\* indicates that the Federal Government has provided over \$100 billion in support of conventional energy over the 1918-1977 period (Table 6). While issue may be taken with the exact figure, it is clear that conventional energy sources have been substantially subsidized.

Price regulations, however, provide a much larger price advantage to conventional fuels. Electricity, gas and oil were sold last year substantially below their replacement costs, due in part to Federal price controls on oil and gas, and in part to state-regulated, average-cost utility rate structures. A preliminary analysis by the Department of Energy compares average user prices of oil, gas and electricity with their replacement costs.

An Analysis of Federal Incentives Used to Stimulate Energy Production,  
Battelle Pacific Northwest Laboratories, March 1978.

Due to the paucity of information in this area, it is virtually impossible for policy analysts to accurately project real resource costs of energy for their area. Hence, the analysis is limited to the use of user price projections. In the case of oil and gas, where prices are expected to gradually increase to their replacement costs, this omission is not as serious. In the case of electricity, however, user prices will be a poor indicator of resource costs in areas where utilities continue to have regulated rate structures. Analysts who are trying to quantify the cost differences among energy alternatives should always note this discrepancy. A correction can be made by performing "sensitivity analysis." For example, one can first estimate the positive direct and secondary employment effects of an energy alternative, and then determine how high the energy costs would have to be either offset these effects, or make one indifferent between the alternative in question and an alternative one. These "implicit" replacement costs can then be compared to those in table 7 (after taking account of real cost escalation) to assess whether they are at all reasonable expectations for the future.

There are many sources for energy user prices, including local utility rates, energy companies, local, state and national energy offices and research institutions (see, for example, a description of the Bechtel and SERI study in section I, part 1). Useful data is also available from recent publications including:

- o 1977 Annual Report to Congress. Vol. I, II, III, Energy Research Administration, U.S. Department of Energy DOE/EIA-0036/I, II, III (1978). This report contains historical data and projections of energy use and energy prices by sector. Energy sources include coal, electricity, natural and liquid gas, petroleum products and other. Regional information is also available, although detailed.

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\*The Domestic Policy Review of Solar, A Response Memorandum to the Study, December 1978. Available from: U.S. Department of Energy, Advanced Energy Systems Policy Division.

\*\*It should be noted that these comparisons do not capture the wide regional variability. For example, current gas prices range from \$3.25/mmBtu in San Francisco-Oakland to \$4.05/mmBtu in New York. In all-electric heating rates range from \$3.25/mmBtu in Seattle (the next lowest is Chicago) to \$17.80/mmBtu in New York.

TABLE 6. An Estimate of the Cost Incentives Used to Stimulate Energy Production (in Billions of 1977 Dollars)

	<u>Nuclear</u>	<u>Hydro</u>	<u>Coal</u>	<u>Oil</u>	<u>Gas</u>	<u>Electricity</u>	<u>Total</u>	<u>Percent Total I</u>
ments		1.8	4.03	50.4	16.04	31.37	103.64	4
ments	1.1	0.03	0.67	41.9	0.06		1.10	
al Services			2.31	6.0		0.48	8.79	2
ditional es	15.1		2.68	1.5	0.3		19.58	
ctivity	<u>1.8</u>	<u>13.5(a)</u>	<u>0.02</u>	<u>0.4</u>	<u>0.1</u>	<u>24.73(a)</u>	<u>40.55</u>	<u>11</u>
	18.0	15.33	9.71	101.3	16.50	56.58	217.42	11
of Total ives	8.3	7.0	4.5	46.6	7.6	26.9	100.0	

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ue based on incentive definition 1 (Federal money outstanding).

(\$ /mmBtu)

(\$ /mmBtu)

(\$ /mmBtu)

Natural Gas<sup>a</sup>

Residential	2.80	2.56	0
Commercial	2.80	2.28	0
Industrial	2.80	1.87	0
Utility	2.80	1.60	1

Electricity<sup>b</sup>

Residential	10.21	9.59	0
Commercial	10.21	9.50	0

Petroleum Products<sup>c</sup>

National Average	2.80	2.33	0
------------------	------	------	---

<sup>a</sup>Replacement cost represents the delivered price of industrial distillate at current world oil prices. Average prices represent 1977 user prices converted to 1978 dollars.

<sup>b</sup>Replacement cost represents in-service costs for a new baseload coal powerplant using bituminous coal, scrubbers at 85 percent removal efficiency. This cost includes all of transmission costs and 25 percent of distribution costs. Baseload costs were used because in 1977, solar generally cost more than baseload generation. Coal was used here because it represents the most common type of baseload plant, thus, providing an upper-bound estimate.

<sup>c</sup>Average electricity prices for 1977 were adjusted to 1978 dollars. Seventy-five percent of the average distribution cost was deducted from average electricity prices. This adjustment was made because potential solar users will already be connected to the grid for lighting and other uses of electricity. Hence, the additional electricity will generally include only a fraction of distribution costs.

<sup>d</sup>Replacement costs represent the average landed price of imports in 1978 dollars, converted into mmBtu at 5.8 mmBtu/bbl. Average prices exclude refinery acquisition costs.

Source: The Domestic Policy Review of Solar, A Response Memorandum to the President, December 1978. Available from: U.S. Department of Energy, Advanced Energy Systems Policy Division.

Applications of Solar Technology to Today's Needs. Vol. 1 and 2. Office of Technology Assessment, U.S. Congress, Washington, D.C., September 1978. This is an excellent source of information on solar applications and includes cost projections for solar and conventional energy in four sample cities: Albuquerque, New Mexico; Boston, Massachusetts; Fort Worth, Texas; and Omaha, Nebraska. Available from the Superintendent of Documents, U.S. Government Printing Office, Nos. 052-003-00539-5 and 052-003-00608-1.

New England Blueprint for Energy Action. (March 1979) By the New England Energy Congress, presents projections of energy costs (to consumer) to the year 2000 for New England. The energy sources include solar, gasoline, natural gas, heating oil, wood and residuals, coal, and electricity (by fuel type). For a copy of this report write to:

New England Energy Congress  
14 Whitfield Road  
Somerville, Massachusetts 02144  
617/625-6528

• Who realizes energy cost savings/increases? This part of the pricing/substitution effect is usually predetermined by the policies used to encourage a particular energy source over another. For example, if a particular energy source is encouraged via mandatory requirements, then private consumers will realize any energy cost savings or bear the burden of any cost increases.\* Alternatively, if the use of a particular energy source is encouraged through Government subsidies (such as tax credits, subsidized interest, etc.), then the Government will pay for the difference in energy costs.

• Behavior of energy consumers facing increased/decreased energy costs. Once it is determined who realizes energy cost savings/increases, it is necessary to determine how these cost changes affect consumption patterns. It is particularly difficult to determine these effects if the

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public sector also realizes energy cost savings/increases if it is required to use a particular energy source (e.g., in public housing or municipal services).

If private energy consumers experience changes in energy costs, are several steps in estimating the effect of these changes on consumption investment patterns. First, it is necessary to determine the types of users affected by the energy policy (i.e., households or businesses). This is usually determined by the energy regulations themselves: many of the regulations are directed towards specific end-use sectors (i.e., residential, commercial, or industrial\*). Analysis of energy consumption patterns by sector may be useful if a general energy source is encouraged by the policy in question (such as oil or gas). This information can be obtained from local energy companies, public utilities, or local, state and national energy offices (see the references in section A above).\*\*

Second, it is necessary to determine the extent to which an additional dollar of income is consumed or saved/invested by households and businesses. The following references are useful for obtaining this information:

- o Sourcebook: Statistics of the Income; Active Corporation Income Tax Returns, U.S. Internal Revenue Service, provides information on corporate profit levels, percentage reinvested and percentage paid as dividends. Available for reference use in most major libraries.
- o The BLS 1972/1973 Consumer Expenditure Survey, provides information on taxes and consumption expenditures averaged over respondents in each income class. This information can be used to estimate consumption as a fraction of disposable income, or to analyze categories of consumption expenditures. For results of this survey, free of charge, contact the BLS.

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\*Residential energy use is usually attributed to households. Commercial energy use refers to the use of energy in commercial/industrial buildings. Industrial energy use usually refers to the use of energy for industrial processes.

\*\*In addition, information on energy use by industry is available in the Annual Survey of Manufacturers: Fuel and Electric Energy Consumed by Manufacturers, Bureau of Census, which contains data for the Nation, SMSA's. Reports are available from the Government Printing Office for \$1.00 per copy. Data tapes are available from Data Users Services Division, Bureau of Census, for about \$80.

. The employment effects of respending/substitution. Once the effect of energy cost savings/increases on consumption and investment are determined, it is necessary to relate these effects to changes in the level of employment (and earnings) in the economy. There are several methods that have been used in previous studies to determine this relationship:

Input-output coefficients. The multipliers associated with the household sector in I-O models can be used to determine the average number of labor years and earnings per million dollars of disposable income spent in (or withdrawn from) the region. This procedure can only be used with I-O models that include households in the A-matrix (such as RIMS). The procedure is used in:

The Long Island Jobs/Energy Study, Council on Economic Priorities  
(April 1979 FINAL DRAFT).

Contact: Steven Buchsbaum  
CEP  
84 Fifth Avenue  
New York, New York 10011  
212/691-8550

See also:

Energy and Labor Impact of Final Demand Expenditures, 1963 and 1967, Robert A. Herendeen, et al., Center for Advanced Computational Studies, University of Illinois, CAC Technical Memo No. 62 (October 1976).  
Cost: \$3.00.

Labor and Net Energy Effects of a National Ceiling Insulation Program, Charlotte Ford, CAC publication (September 1978).  
Contact: Charlotte Ford, CAC  
217/333-3242

This latter publication indicates that, in 1967, money invested in energy conservation average investments produced 9.2 jobs per \$100,000 while money spent on



- o Income elasticities. For I-O models that exclude households in A-matrix, the implicit income elasticities in macroeconomic model be used to estimate how a change in income will affect various tion items. These changes can then be "mapped" into an I-O model structure to produce estimates of total final demand, earning a employment. This has been done using the 1978 version of the D Quarterly Macroeconomic Model of the U.S. Economy and the BLS n I-O model. See:

Macroeconomic Impacts of Utility Retrofit Program-Solar.

(DRAFT: September 1978)

Science Applications, Inc./JRB Associates, Inc.

8400 Westpark Drive

McLean, Virginia 22102

Contract No. EM-78-C-04-4261

Contact: Jerry Lawry

202/821-4325

The Data Resources, Inc. Model, Otto Eckstein, Lexington, Massachusetts (1978) "Consumer Spending," Table 2.

The preceeding discussion is designed to provide the policy decision a list of relevant considerations and sources of information for determining the responding effects of energy policy choices. This list is by no means exhaustive: It represents a useful starting point for continuing research and analysis in this area.

Part 5. Financing Effects. As discussed briefly in section I, the employment effect of a policy choice will also depend on the way that energy investment is financed. The financing effects of energy policies require estimation in almost all cases where the economy in question is large and diversified. For small, undiversified economies, financing the energy investment will generally draw funds from outside the region (with the exception of direct local taxation).

In order to estimate the financing effects, it is necessary to determine

Most of the discussion presented in part 4 ("Responding/Substitution Effects") applies here. The answer to question 1 will usually be predetermined by the policies established to encourage a particular energy source or another. Question 2 can be answered using the same references presented in 4D. As in the case of responding/substitution effects, it is difficult to determine the effects of financing on employment/earnings when public debt is the source of funding. If the investment is financed through private debt, assumptions must be made about the terms (length and interest rate) of the debt in order to determine the annual amount of funds being diverted from consumption to expenditures or savings/ investment. In addition, several "sensitivity analyses" must be done by varying the types of policies used to finance solar (e.g., credits, grants, tax exempt bonds, interest subsidies). Comparing the employment effects associated with each policy alternative may provide a basis for choosing the optimal policy.

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Public investment is not directly included here because it is, in effect, financed through either increased taxation (and hence reduced consumption) or public debt.

## APPENDICES

This appendix presents, primarily in table form, a review of direct and indirect labor requirements for energy technologies from various written sources. It is expected that the policymaker can select pertinent information from these tables, and make additions to this data when other, more specific information is available.

- (1) Table A-1. This table summarizes the results of several studies on the direct labor requirements of solar flat-plate collector systems.
- (2) Table A-2. This table summarizes the results of several studies (including those sources for table A-1) on the direct and indirect labor requirements for passive solar and solar flat-plate collector systems.
- (3) Table A-3. This table summarizes the results of a MITRE study on direct labor requirements for solar technologies, exclusive of flat-plate collector systems.
- (4) Tables A-4 to A-14. These tables summarize the results of a 1976 Argonne National Laboratory study\* which evaluated the construction and operating labor requirements of various sized facilities for each of eight separate technologies: coal extraction, oil shale extraction and conversion, offshore oil and gas extraction, nuclear powerplants, coal-fired electric generating plants, gasification, liquefaction plants, and geothermal facilities.
- (5) Table A-15. Summarizes the results of a 1978 study by Charlotte Ford at the Center for Advanced Computation, University of Illinois. The study estimates the direct and indirect labor requirements for manufacture, transportation, sale and installation of insulation.

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Framework for Projecting Employment and Population Changes Accompanying Energy Development: Phase I. Erik Stenehjem and James E. Metzger, Energy Environmental Systems Division, Argonne National Laboratory, Argonne, Illinois, 1976.

estimates relate to a program that includes:

- o Retrofitting one-half of the 116,500 schools and colleges in the Nation. Measures would include installing weatherstripping, caulking, insulation and double-glazed windows.
  - o Retrofitting one-half of the 6,000 non-Federal, non-military hospitals in the United States (measures are same as above).
  - o Retrofitting all of the 403,000 Federal buildings (measures are same as above).
  - o Weatherizing 1.35 million homes occupied by low-income families. The program would be run by state and local governments.
  - o Weatherizing 50,000 HUD-owned single-family homes and installing solar water heaters in 10,000 of these homes.
  - o Constructing 4,000 miles of bikeways for which funding is already pending.
- (7) Table A-17. The Environmental Protection Agency's Action Handbook is an excellent "how to manage" manual for communities with a bright prospect of accelerated growth. Volume I provides workable methods for estimating peak employment and population projections for various types of energy development activities. The portions dealing with calculating direct employment effects are presented in

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\*The FEA analyses are summarized by S. Lynn Sutcliff and Allan J. Berman in a Senate Commerce Committee memorandum submitted to the Carter Task Force (December 14, 1976).

\*\*The Action Handbook (EPA 9081/4-78-005a) is available, free of charge, from Joel Webster, EPA, Region 8, 1860 Lincoln Street, Denver, Colorado 80202, 303/837-4904.

summarizes the wage rates for technical, nontechnical and manual by energy facility. Table A-19 presents total construction man costs, calculated as the products of the hourly rates in table and the original man-hour estimates from ESPM. Descriptions of energy facilities included in ESPM are available in:

Resource Requirements: Impacts and Potential Constraints Associated with Various Energy Facilities. Research and Engineering, Bechtel National, Inc. (San Francisco, August 1978) Appendix B.

- (9) Table A-20. This table summarizes the direct labor requirements for a 4 MWe wind turbine generator, as estimated in a Lockheed Aircraft mission analysis for ERDA.\*\*\*

In addition to the studies mentioned above, a forthcoming book by Steve H. Murdock and Larry Leistritz summarizes the direct employment requirements and indirect employment multipliers for typical Western energy resource development projects:

Energy Development in the Western United States: Impact on Rural Areas. New York: Praeger Publishers, 1979 (in press).

Contact: Larry Leistritz  
Department of Agricultural Economics  
Texas A&M University  
College Station, Texas 77843  
713/845-2333.

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Escalation in the Costs of Manpower, Materials and Equipment Needed for Facilities. Research and Engineering, Bechtel Corporation (San Francisco, October 1977) PAE-3794-F.

See section 3, part 1 for a description of the ESPM data base.

\*Lockheed Aircraft Corporation, Wind Mission Analysis Study for ERDA, Report. LR-27611, 1976. A summary of these results are published in: "High Potential of Wind as an Energy Resource." U. Coty and M. Dubey. Lockheed California Company, Second Annual Energy Symposium, Los Angeles Council of Engineers and Scientists, May 19, 1976.

<u>Type of System</u>	<u>Low</u>	<u>Mid</u>	<u>High</u>
Hot Water	0.55	0.76	1.0
Hot Water, Space Heat	0.45	0.55	0.64
Hot Water, Space Heat, Space Cooling	0.68	0.79	1.1
Direct Employee Hours per MMBtu/year (on an actual energy output basis per year of system operation) <sup>b</sup>			
Hot Water	2.04	2.81	3.70
Hot Water, Space Heat	3.46	4.23	4.92
Hot Water, Space Heat, Space Cooling	4.25	4.94	6.88

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<sup>a</sup>Direct employment here includes collector manufacturing, system installation and maintenance. It does not include component manu

<sup>b</sup>Calculations are based on the following estimates of heat output per foot of collector: Hot Water, 0.27 MMBtu (actual)/ft<sup>2</sup>; Space Heat, 0.13 MMBtu (actual)/ft<sup>2</sup>; and Space Heat/Space Cooling/Hot Water, 0.13 MMBtu (actual)/ft<sup>2</sup>.

$$\text{eh/MMBtu/year} = \frac{\text{eh}}{\text{ft}^2} \times \frac{\text{ft}^2}{\text{MMBtu}}$$

Virginia: MILKE Corporation, MILKE Working Paper No. 12569 (September 1977).  
Charles G., et al., Assessment of Need for Developing and Implementing a Semi-Skilled and Skilled Worker for the Solar Energy Industry, Final Report, Houston, Texas: Navarro College (DOE No. EG 77-S-104-3869 (January 13, 1978).

David and Fred Branfman, Job from the Sun; Employment Development in the California Solar Energy Industry, Los Angeles, California: California Energy Policy Center (February 1978).

John, Keith Armington, Direct Labor Requirements for Select Energy Technologies: A Review and Synthesis. SERI Working Paper, August 1978.

Impacts of Solar Energy Development, Report to the Impacts Panel by the Independent Impacts Task Force, Advanced Energy Systems Policy Division, U.S. Department of Energy, September 1978.



<u>System</u>	<u>Direct Labor</u>	<u>Indirect Labor</u>	<u>Total</u>
Passive	1.70	2.60	4.30
Hot Water	2.81	5.62	8.43
Hot Water, Space Heat	4.23	8.46	12.69
Hot Water, Space Heat, Space Cooling	4.94	9.88	14.82

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SOURCES: Estimates for passive are based on assumptions used by the Impacts Task Force, Labor Impacts of Solar Energy Development, Domestic Policy Review of Solar, Advanced Energy Systems Division, USDOE. September 21, 1978, p. 9.

Estimates for flat-plate collector systems are based on (direct) and independent input-output estimates from BLS Herendeen, Center for Advanced Computation, University of (see Task Force Report cited above).

Technology	Demand Type	Capacity		MY/KW	MHR/MMBtu/yr. (Actual)	Costs \$/MMBtu	Costs \$/MMBtu
		MW	Factor				
Solar Thermal Central Receiver, 3-hour storage	Semi Peak	100	0.35	0.013	2.32	31.93	22.26
Solar Thermal Central Receiver, 6-hour storage	Semi Peak	100	0.50	0.017	2.12	32.69	23.84
Solar Thermal Central Receiver	Fuel Saver	100	0.30	0.010	2.09	32.69	24.00
PV with Storage Collector/Reflector 16% Silicon	Semi Peak	100	0.30	0.025	4.25	44.33	26.57
PV with Storage Collector/Reflector 10% Thin Film	Semi Peak	100	0.30	0.041	3.33	34.82	20.85
PV with Storage Collector/Reflector 16% Silicon	Intermed.	100	0.45	0.04	4.62	48.20	28.96
PV with Storage Collector/Reflector 10% Thin Film	Intermed.	100	0.45	0.067	3.96	38.56	23.12

: All estimates are in terms of actual energy output. In order to convert these data to a MMBtu/oil displaced basis, all estimates would be divided by three (i.e., 1 Btu produced at the point of the equivalent of 3 Btu input in the form of primary energy, following the rule for electricity that it takes 10,400 Btu of primary energy to generate 1 kWh of electricity, versus the actual of 3,413 Btu per kWh).

TABLE A-3 (continued)

Technology	Demand Type	Plant Capacity MW	Capacity Factor	Direct Labor:			Capital Material Costs \$/MMBtu
				Fabrication/Shipping/Install MY/KW	MTR/MMBtu/yr. (Actual)	Costs \$/MMBtu	
PV with Storage 10X Concentration/ Verticle Tracking	Intermed.	100	0.45	0.045	6.33	65.86	39.44
PV Collector/ Reflector 16% Silicon	Fuel Saver	100	0.28	0.017	3.21	33.43	20.02
PV Collector/ Reflector 10% Thin Film	Fuel Saver	100	0.26	0.027	2.43	25.46	15.24
PV 10XCPC/ 16% Silicon	Fuel Saver	100	0.30	0.035	6.06	63.17	37.89
WECS with Hydro- Electric Hybrid	Intermed.	100	0.48 18 mph	0.0054*	0.705	17.96	15.02
Advanced WECS with Gas Turbine	Intermed.	100	0.49 14 mph	0.0050*	0.678	21.08	18.26
Advanced WECS with Combined Cycle	Baseload	100	0.87 18 mph	0.0085*	0.612	13.58	11.03
WECS	Fuel Saver	1.5 22.4 mph	0.30	0.0051*	1.065	23.02	18.58

TABLE A-3 (continued)

Demand Type	Plant Capacity MW	Capacity Factor	Direct Labor:			Capital Costs \$/MMBtu	Material Costs \$/MMBtu	Indirect Labor MER/MMBtu (Actual)
			Fabrication MY/KW	Shipping/Install MER/MMBtu/yr. (Actual)	Costs \$/MMBtu			
Log								
Fuel Saver	1.5	0.65	0.0085	0.619	14.04	10.63	0.89	
	17.1 mph							
Intermed.	100	0.05	0.007	0.676	17.05	13.25	1.12	
Baseload	100	0.80	0.008	0.627	10.65	8.04	0.67	
Heat-Processing	68,750 MMBtu			0.990	8.73	9.00	0.50	
Hot Air Dryer	70,200 MMBtu			0.657	9.85	7.11	0.59	
Hot Water Heating System	38,250 MMBtu			0.561	9.22	6.88	0.57	
Hot Air Curing	29,565 MMBtu			2.010	26.48	15.89	1.33	
Electric dam	0.981 x 10 <sup>9</sup> kWh			0.702	8.46	4.93	0.41	
Baseload	264.5	0.61		2.622			1.67	
Baseload		0.61		2.001			1.13	

TABLE A-3 (continued)

Technology	Demand Type	Plant Capacity MW	Capacity Factor	Direct Labor:			Capital Costs \$/MMBtu	Material Costs \$/MMBtu
				Fabrication/MY/KW	Shipping/Install MHR/MMBtu/yr. (Actual)			
OTEC 7 plants	Baseload	264.5	0.61		1.535			
Biomass-Methanol		3.82 x 10 <sup>6</sup> MMBtu			0.405	4.23		
Biomass-Medium Btu Gas		6.34 x 10 <sup>6</sup> MMBtu			0.099	1.03		0.62
Biomass-Substitute Natural Gas		5.58 x 10 <sup>6</sup> MMBtu			0.198	2.09		1.25
Biomass-Process Heat 850 ton/day	Steam	3.86 x 10 <sup>6</sup> MMBtu			0.192	2.01		1.20
1,700 ton/day	Steam	8.40 x 10 <sup>6</sup> MMBtu			0.135	1.43		0.88
3,400 ton/day	Steam	17.64 x 10 <sup>6</sup> MMBtu			0.105	1.09		0.66

TABLE A-3 (continued)

EE: Unit labor estimates computed from data presentes in:

- Systems Description and Engineering Costs for Solar-Related Technologies, Volume I, Summary MITRE Corporation, Metrek Division, June 1977.
- Systems Description and Engineering Costs for Solar-Related Technologies, Volume III, Agriculture and Industrial Process Heat. The MITRE Corporation, Metrek Division, June 1977.
- Escalation in the Costs of Manpower, Materials, and Equipment Needed for Energy Facilities, Corporation, October 1977. Resource Requirements, Impacts, and Potential Constraints Association Various Energy Futures. Bechtel National, Inc., March 1978.
- Systems Descriptions and Engineering Costs for Solar-Related Technologies, Volume VII, Ocean Energy Conversion. The MITRE Corporation, Metrek Division, June 1977.
- Systems Description and Engineering Costs for Solar-Related Technologies, Volume IX, Biomass Production and Conversion System. The MITRE Corporation, Metrek Division, June 1977.

Region, Size and  
Type of Coal

	Personnel		
	Production	Maintenance	Supervision

Eastern

(Bituminous)

1MM	37	22	18
3MM	63	38	28
5MM	100*	54	24

Interior

(Bituminous)

1MM	40	23	15
1MM	36	23	16
1MM	57	18	18
3MM	68	29	15
6.7MM	106*	54	24

N. Great Plains

(Subbituminous)

1MM	27	11	9
5MM	66	18	11
5MM	53	22	14
9.2MM	126*	63	24

Southwest

(Lignite)

1MM	29	11	9
5MM	74	32	17

\*Production figures include reclamation and road building.

SOURCE: Basic Estimated Capital Investment and Operating Costs for Strip Mines, U.S. Department of Interior, Bureau of Mines Circulars 8661 (1975) and 8703 (1976).

Note: All mines were assumed to have a 20-year life. The Argonne compared BOM data with two other sets of data on employment in mines (A-5 and A-6). The Argonne study concludes that "The present picture understates the actual mine performances ... by up to 33 percent, depending on the size of mine. The user of these figures must be aware of the probable underestimation that strict adherence to these figures involves."

am

	202	11	44	257
	390	15	59	464
	585	18	74	677

am

	192	11	43	246
	357	15	56	428
	544	18	71	633

: Basic Estimated Capital Investment and Operating Costs for Undergro  
Bituminous Coal Mines, U.S. Department of Interior, Bureau of Mines  
Information Circulars 8689 (1975) and 8682A (1976).

All mines were assumed to have a 20-year life.



Location	Technique	1960/1961	Manpower	Seams
E. Kentucky	multi-pit	1.75M	200	18",22",40"
Tennessee	contour & multi-pit	.35M	85	65",54",27 24"
West Virginia	modified block cut	.085M	14	17"
Pennsylvania	"typical dragline" "previous stripping of outcroppings"	.5M	33*	42"
W. Pennsylvania	"previous contour stripping"	.12M	24	24-28"
W. Pennsylvania	"family type of organization"	.24M	19	48-60"
Ohio	1 of 8 active pits	.6M	99	47"
Ohio	modified area technique	.14M	38	34"
S. Illinois		.3M	157	5',3.5' (2 pits)
S. Indiana	"typical Midwest mine"	.144M	157	54"
Colorado	large corporate structure, "traditional technique"	1.8M	99	7-10', 4' (2 pits)

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\*Some contracting of work.

oming	3M	102	3-20'	"geologic structure very complex"
ntana	5M	162	52"	unknown
kota	2M	70	20' (total for 3 pits)	60'

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Economic Engineering Analysis of U.S. Surface Coal Mines, Skelly  
& Loy Consultants, 1975; chapter 9, pp. 1-186.

Location	Output	Manpower	Seams
Eastern	.73MM	62	3',8' (two pi
Midwest	1.45MM	166	45'
Northern Great Plains	3.30MM	137	24',8.5' (two
Southwest	7.00MM	454	unknown

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SOURCE: Operation Study of Selected Surface Coal Mining Systems  
United States, Theodore Barry and Associates, NTIS PB-24  
1975.

Develop- ment	Support Services	Platform Forms	Pipeline Terminals	Gas Processing Plants	Office	Opera- tions Base	Construc- tion	Facility	Totals
	58						40		263
	58							120	343
	58							347	735
	58						40	345	1103
95	116	16					40	345	1372
55	116	48						365	2041
15	174	112			14	45	467	363	2715
45	232	160	17	34	14	45	40	390	2602
05	232	240	17	34	14	45		419	2766
00	290	320	17	34	14	45	207	452	3339
55	348	848	34	68	45	145	367	500	4285
	58	960	51	102	77	250		(500)	2163
	58	848	51	68	67	218		(500)	1975
	58	400	17	34	31	100		(500)	1305

ility continues construction after year 16 for other areas.

atform contruction ceases after year 16.

rom calculations by Woodward-Clyde Consultants, Mid-Atlantic Regional Study, Table 2-2.

med that the productive life of the oil and gas fields was 22 years, with 8 years of exporation  
at. The Argonne study recognizes that "further development is, of course, a possibility,  
if new finds are made. Users of the employment projections must be aware of this possibility  
they are of the small probability that nothing will be recovered beneath the seas."

TABLE A-9: CONSTRUCTION AND OPERATION MANPOWER REQUIREMENTS  
FOR SELECTED NUCLEAR POWERPLANTS, BY YEAR

on Employment	BELLEFONTE <sup>a</sup>			MC GUIRE <sup>b</sup>			RIVER BEND <sup>c</sup>			SUSQUEHANNA <sup>d</sup>			HYPOTHETICAL <sup>e</sup>		
	Construc- tion Employ- ment	Opera- tion Employ- ment	Construc- tion Employ- ment	Opera- tion Employ- ment	Construc- tion Employ- ment	Opera- tion Employ- ment	Construc- tion Employ- ment	Opera- tion Employ- ment	Construc- tion Employ- ment	Opera- tion Employ- ment	Construc- tion Employ- ment	Opera- tion Employ- ment	Construc- tion Employ- ment	Opera- tion Employ- ment	AVERAGE
	Alabama	North Carolina	Louisiana	Pennsylvania	—	—	—	—	—	—	—	—	—	—	—
2430	850	0	850	0	100	0	300	0	395	2100	0	1164	2200	2200	2200
2240	1500	0	1537	0	350	0	1800	0	1164	2500	0	1872	2080	2080	2080
170	2150	0	1810	0	1200	0	2300	0	1872	77	0	2080	140	140	140
	2240	30	1654	0	2100	0	2500	0	2080						
	1660	155	950	30	2000	0	2400	0	1810						
	630	170	200	170	1650	0	1500	0	1221						
	0	170	0	200	1000	30	800	0	479						
	0	170	0	200	300	70	250	20	0						
	0	170	0	200	0	100	100	60	0						
	0	170	0	200	0	100	0	77	0						
	0	170	0	200	0	100	0	77	0						
	0	170	0	200	0	100	0	77	0						
	0	170	0	200	0	100	0	77	0						

Preliminary Safety Analysis Report, Bellafonte Nuclear Plant, Tennessee Valley Authority.  
Environmental Report, Operating License Stage, William B. McGuire Station, Units 1 & 2, Duke Power Company.  
Environmental Report, Construction Permits Stage, River Bend Units 1 and 2, Gulf States Utilities Company.

COAL-FIRED ELECTRIC GENERATING PLANTS, BY YEAR

	Colstrip 3 & 4a	Tonbigbee 2 & 3b	Kaiparowits (4 Units) <sup>c</sup>	Jim Bridger (2 Units) <sup>d</sup>	Bechtel - Loe	Bechtel
	Montana	Alabama	Utah	Wyoming	--	--
	700	420	3000	500	800	800
	No	No	Yes	Yes	No	No
	1750	1200	3105	3000	2850-4071	2400-
	693	450	3135	282	125	100
	Operations Employment	Operations Employment	Operations Employment	Operations Employment	Operations Employment	Operations Employment
	180	0	0	0	0	77
	972	0	2430	0	0	806
	0	0	2430	0	0	1661
	972	0	2430	0	0	1565
	180	112	783	70	0	1565
	693	0	3135	282	31	691
	0	450	0	282	0	0
	693	450	3135	282	125	0
	0	450	0	282	0	0
	693	450	3135	282	125	0
	0	450	0	282	0	0
	693	450	3135	282	125	0

Draft Environmental Impact Statement for Colstrip Electric Generating Units 3 and 4, Energy Planning Division, Montana Department of Natural Resources and Construction, Helena, Montana, November 1974, Vol. 3-A, p. 181.

on Environmental Analysis, Tombigbee Power Plant Site, Leroy, Alabama,  
Burns and McDonnell, Kansas City, Mo., 1977  
B-51, 52.

Environmental Impact Statement, Kaiparowits Project, Bureau of Land Management, Department of the Interior, March 1970.

the Energy Supply Planning Model, Bechtel Corporation, NTIS PB-245382, August 1975.

TABLE A-11: CONSTRUCTION AND OPERATION MANPOWER REQUIREMENTS FOR OIL-SHALE CONVERSION PROCESSES, BY YEAR

	Project Independence <sup>a</sup>			EIS Prototype <sup>b</sup>			Bechtel <sup>c</sup>		
	Surface		In-Situ	Surface		In-Situ	Surface		
	Construction Employment	Operations Employment	Construction Employment	Construction Employment	Operations Employment	Construction Employment	Construction Employment	Operations Employment	Construction Employment
678	0	914	0	1470	0	1240	1376	0	82
1220-1470	0	1827	0	1470	0	1240	4121	0	331
678	277	914	289	1470	323	1240	5963	0	501
0	1110	0	1158	0	1293	1240	5040	385	448
0	1110	0	1158	0	1293	1240	4485	1138	374
0	1110	0	1158	0	1293	1240	0	1138	0
0	1110	0	1158	0	1293	1240	0	1138	0
0	1110	0	1158	0	1293	1240	0	1138	0

- (a) Interagency Task Force on Oil Shale, Federal Energy Administration, Project Independence Blueprint Final Report, Washington, D.C., November 1974, quoted in Synthetic Fuels Commercialization Program, Draft Environmental Statement, Washington, D.C., November 1975.
- (b) EIS for the Prototype Oil Shale Leasing Program, U.S. Department of Interior, Vol. I, pp. III-247 and 248.
- (c) The Energy Supply Planning Model, Bechtel Corporation, NTIS PB-245382, 1975.

TABLE A-12: CONSTRUCTION AND MANPOWER REQUIREMENTS FOR COAL GASIFICATION, BY YEAR

FEA-HIA	FEA-Loa		WESCOb		EL PASOC		MICHWISd	NATIONAL
	Operations Employment	Construction Employment	Operations Employment	Construction Employment	Operations Employment	Construction Employment		
	0	68	0	2050	0	330	0	0
	0	157	45	3450	0	1998	33	0
223	223	197	181	4300	153	3617	586	231
891	891	0	181	3450	612	2056	1234	929
891	891	0	181	4300	612	3296	1806	925
891	891	0	181	3450	612	1757	2628	929
891	891	0	181	4300	612	294	3009	925
891	891	0	181	3450	612	0	3009	925
891	891	0	181	2050	612	0	3009	925
891	891	0	181	0	612	0	3009	925
891	891	0	181	0	612	0	3009	925
891	891	0	181	0	612	0	3009	925
891	891	0	181	0	612	0	3009	925

Interagency Task Force on Synthetic Fuels from Coal, Federal Energy Administration Project Independence Blueprint, Final Task Force Report, Washington, D.C., November 1974.

Draft Environmental Statement, WESCO Complex, Department of Interior Bureau of Reclamation, 1-74; pages 1-66 and -71.

Draft Environmental Statement, El Paso Gasification Project, chapter 3, table 3-11, page 54.

Coal and Water for Future Gasification, Michigan-Wisconsin Pipe Line Company, February 1973, section II, page 6.

Summary Description, Dunn Center Coal Gasification Project, National Gas Pipeline Company, 1975.



Years	Fischer-Tropsch <sup>a</sup>		Direct <sup>a</sup>		Bechtel-
	Construc- tion Employ- ment	Opera- tions Employ- ment	Construc- tion Employ- ment	Opera- tions Employ- ment	Construc- tion Employ- ment
1	283	0	286	0	200
2	495	0	569	0	1200
3	510	0	569	0	2100
4	758	148	490	138	2300
5	191	593	186	554	1200
6	0	593	0	554	0
7	0	593	0	554	0
8	0	593	0	554	0
9	0	593	0	554	0
10	0	593	0	554	0
20	0	593	0	554	0
30	0	593	0	554	0

SOURCES: (a) Interagency Task Force on Synthetic Fuels from Coal  
Energy Administration Project Independence Blueprint  
Force Report.

(b) Bechtel Energy Supply Planning Model.

Location	GEYSERS <sup>a</sup>		IMPERIAL VALLEY <sup>b</sup>		BECHTEL <sup>c</sup>	
Output	110 MWe		135 MWe		200 MWe	
Number of Wells	12-20		20-30		Undetermined	
Peak Construction	30		80		374	
Operations	81		10		83	
Years	Construc- tion Employ- ment	Opera- tions Employ- ment	Construc- tion Employ- ment	Opera- tions Employ- ment	Construc- tion Employ- ment	Opera- tion Empl- ment
1	20	0	40	0	126	0
2	20	20	80	10	374	0
3	0	81	40	10	265	21
4	0	81	0	10	228	60
5	0	81	0	10	0	83
10	0	81	0	10	0	83
20	0	81	0	10	0	83
30	0	81	0	10	0	83

SOURCES: (a) Conversation with Union Oil representative.

(b) Conversation with Pacific Gas & Electric Company representative.

(c) Energy Supply Planning Model, Bechtel Corporation.

Note:

Construction data for Geysers and Imperial Valley does not include the well digging, normally done on a contractual basis and employing approximately 75 people per well. It is also unclear whether or not Bechtel constructed any wells for the Geysers or Imperial Valley.

	Type of Insulation	
	Mineral Wool	Cellulose
	(person-yr. 1 ft. <sup>2</sup> )	(person-yr. 1 ft. <sup>2</sup> )
Manufacture--Total	$(8.430 + 7.306 X^{**}) \times 10^{-7}$	$5.090 \times 10^{-7}$
direct	-	$3.1124 \times 10^{-7}$
indirect	-	$1.9776 \times 10^{-7}$
Transportation and Sale--Total	$(1.059 + 0.918 X) \times 10^{-7}$	$3.101 \times 10^{-7}$
Installation (direct only)	$1/(352,500 - 7,833 X^{*})$	$1.120 \times 10^{-7}$
<u>TOTALS</u>		$1.939 \times 10^{-7}$

\*Includes labor requirements for the chemical inputs and for collecting the newspaper.

\*\*X = batt thickness in inches.

SOURCE: Labor and Net Energy Effects of a National Ceiling Insulation Program by Charlotte Ford, Center for Advanced Computation, University of Illinois, Urbana-Champaign. (September 1978)

TABLE A-16: COSTS, DIRECT EMPLOYMENT AND ENERGY SAVINGS OF  
SIX ENERGY CONSERVATION PUBLIC WORKS PROGRAMS

DIRECT JOBS CREATED(a)

<u>Program</u>	<u>Costs</u>		<u>DIRECT JOBS CREATED(a)</u>			
	<u>(million 1976 \$)</u>	<u>Unskilled</u>	<u>Skilled(b)</u>	<u>Manuf.</u>	<u>Construction</u>	<u>Total</u>
Retrofit Public Schools & Colleges	290	16,500	1,500	2,000	-	20,000
Retrofit Hospitals	150	9,000	1,000	1,250	-	11,250
Retrofit Federal Buildings	250	15,000	1,000	2,000	-	18,000
Low-Income Weatherization	770	27,000	5,400	10,000	-	42,400
Weatherization & Installation of Solar Water Heaters in HUD Housing	42	2,100	200(c)	250(c)	-	2,550
Bike Path Construction	140	5,000	500	770	-	6,270
TOTAL	1,642	74,600	9,600	16,270	-	100,470

SOURCE: Senate Commerce Committee memorandum by S. Lynn Sutchffe and Alan R. Hoffman to the President, dated December 14, 1976.

Supervisors or carpenters (in the case of retrofits).

Since contracted labor is used to repair HUD-owned homes, public service employees may partially replace local labor.

### Assumptions

- o For most buildings, while a retrofit investment of \$1 per square foot is probably cost effective (i.e., energy savings would repay the retrofit cost on a reasonable time scale), the most labor-intensive retrofit measures are associated with the first \$0.10 of investment per square foot.
- o Of every \$3 spent on building retrofit, \$2 goes for labor and \$1 goes for materials (based on the labor/materials cost split characteristic renovation activities).
- o Each unskilled or semi-skilled public service worker will receive \$10,000 annually.
- o Each skilled public service worker acting in a supervisory role will receive \$15,000 annually.
- o Each \$40,000 of investment in materials will create one job in the manufacturing industry (this figure is an average of several industries and is also the figure specifically applicable to the insulation industry).

### Strip Mining:

employment per 1 million tons/year output	17.5 <sup>2</sup>	66 <sup>3</sup>
--	-------------------	-----------------

### Underground Mining:

employment per 1 million tons/year output	138 <sup>4</sup>	345 <sup>3</sup>
--	------------------	------------------

### Electric Powerplant:<sup>3</sup>

coal fired, hydropower, nuclear)		
employment per 1,000 megawatts capacity	1,000	130

### Oil Shale Mining and Processing:<sup>5</sup>

employment per 1,000 barrels/day output	33	18
---	----	----

### Uranium Mining and Milling:<sup>6</sup>

employment per 100 tons uranium concentrate produced/day	13	22
---	----	----

### Gasification Plant:<sup>3</sup>

employment per million cubic feet/day capacity	4.5	2.4
---	-----	-----

<sup>1</sup>These figures are estimates based on various actual experience vary among energy facilities.

<sup>2</sup>Adopted from A Study of Social, Economic and Public Effects Mines, Bickert, Browne and Coddington, 1976.

<sup>3</sup>Projects to Expand Fuel Sources in Western States, Bureau of

<sup>4</sup>Adopted from Baseline Environmental Report, Proposed, Long C Mine, Dames and Moore, 1976.

<sup>5</sup>Oil Shale and the Future of a Region, Colorado West Area Cou Governments, 1974.

<sup>6</sup>Draft Environmental Statement, Bear Creek Project, Rocky Mou Company, 1976.

\*Note: Large facilities may, because of economies of scale, workers per unit of output than smaller facilities.

<u>Numbers</u>	<u>March 1977 Dollars Per Man-Hour</u>		
	<u>Technical</u>	<u>Nontechnical</u>	<u>Manual</u>
North Alaskan Wells)	41.72	30.17	35.77
Alaskan Pipelines)	35.92	24.13	23.85
(Alaskan Export)	22.75	18.10	20.27
(Solar)	21.55	9.65	16.69
, 4, 10, 12, 13, 20, 21, 23, 25, -1, 6, 7, 8, 12, 13, 14, 17, 18 Gas Extraction and Handling)	20.95	15.08	17.89
, 9, 17, 18, 31, 32, 33, 34, 35, rough 49 (Processing)	17.96	8.45	14.31
ugh 69 and T-9 (Railroad, Generation)	14.37	8.45	15.50
16, 27, 28, 29, 30, 37 through g)	14.37	7.24	13.71
ugh 27 (Electrical Transmission istribution)	12.81	9.65	15.50
, 10, 11, 15, 16, 20 (Mobile s)	None*	None*	None*

titles of the groups are resultant identifiers of how the rates happened. They were not preselected categories.

presents total construction manpower costs, calculated as the product of the rates above and the original man-hour estimates.

facilities (e.g., trucks) are purchased directly and not built in the energy construction industry.

Escalation in the Cost of Manpower, Materials and Equipment Needed for Energy Facilities. Bechtel (1977).



E 1	Onshore Primary Oil Recovery - Lower 48	1,676	226	
E 2	Onshore Secondary Oil Recovery - Lower 48	691	121	
E 3	Onshore Enhanced Oil Recovery - Lower 48	1,194	181	
E 4	Offshore Oil Recovery - Lower 48 and South Alaska	5,762	905	1
E 5	North Alaskan Oil Recovery	5,447	1,810	2
E 6	High-Gasoline Refinery	48,487	5,406	16
E 7	Low-Gasoline Refinery	43,099	4,645	14
E 8	Heavy Fuel Oil Gasification	37,891	3,294	14
E 9	Naphtha Gasification	8,081	1,224	3
E10	Crude Oil Stockpile	5,866	1,056	3
E11	Alaskan Oil Export	38,670	5,430	24
E12	Offshore Crude Oil Import	10,685	2,564	3
E13	Onshore Oil Import	7,542	1,961	2
E14	Surface Oil Shale Mine	5,316	290	6
E15	Underground Oil Shale Mine	12,283	652	3
E16	In-Situ Shale Oil Recovery	8,476	471	2
E17	Oil Shale Retorting and Upgrading	53,874	2,534	20
E18	Shale Oil Upgrading	44,895	2,534	17
E19	Onshore Conventional Gas Recovery - Lower 48	3,352	453	1
E20	Onshore Enhanced Gas Recovery - Lower 48	14,666	2,639	7
E21	Offshore Gas Recovery - Lower 48	8,904	1,131	5
E22	North Alaskan Gas Recovery	5,950	2,051	2
E23	Coal Mine Degasification	105	15	
E24	Alaskan LNG Export	93,262	18,099	45
E25	LNG Import	28,284	6,033	14
E26	Natural Gas Stockpile	4,400	1,056	2
E27	Underground Eastern Coal Mine	1,940	109	
E28	Surface Eastern Coal Mine	3,003	232	1
E29	Surface Western Coal Mine	3,649	268	
E30	Underground Western Coal Mine	1,940	109	

Coal Gasification - High-Btu Gas	66,445	3,379	237,526	30
Coal Gasification - Low- and Medium-Btu Gas	61,057	2,534	198,892	26
Coal Gasification - Methanol	77,219	14,359	286,176	37
Coal Liquefaction - Heavy Fuel Oil	26,937	4,223	71,544	10
Coal Solvent Refining	30,529	1,689	100,162	13
Coal Liquids Refinery	33,402	3,547	97,014	13
Surface Uranium Mine	1,049	43	6,212	
Underground Uranium Mine	632	22	1,934	
Uranium Mill	948	36	2,002	
Uranium Conversion	6,465	869	12,204	1
Uranium Enrichment - Diffusion	235,609	30,406	663,690	92
LWR Fuel Fabrication - No Pu Recycle	6,645	591	13,236	2
LWR Fuel Fabrication - Pu Recycle	5,621	304	12,349	1
HTGR Fuel Fabrication	20,293	1,436	52,513	7
FBR Fuel Fabrication	8,530	591	22,322	3
LWR Spent Fuel Reprocessing	67,702	4,983	169,702	24
HTGR Spent Fuel Reprocessing	16,701	1,183	41,496	5
FBR Spent Fuel Reprocessing	60,518	4,223	151,387	21
High-Level Waste Disposal	5,477	287	14,309	2
Solid Waste Collection/Separation Plant	280	21	1,118	
Oil-Fired Powerplant	7,758	2,196	55,804	6
Reconversion of Oil Powerplant to Coal	29	8	233	
Coal-Fired Powerplant - Low-Btu Coal	10,919	3,041	70,996	8
Coal-Fired Powerplant - High-Btu Coal	9,338	2,618	59,525	7
Coal/Waste Powerplant - Low-Btu Coal	10,631	1,351	31,002	4
Coal/Waste Powerplant - High-Btu Coal	9,769	1,014	26,352	3
Sulfur Oxide Removal	8,620	1,689	18,601	2
Low/Intermediate-Btu Gas-Fired Plant	6,178	1,689	43,403	5
High-Btu Gas-Fired Powerplant	5,603	1,439	34,103	4

E60	Conversion of Gas Plant to Coal	4,417	507	
E61	Combined Cycle Powerplant	4,417	1,183	
E62	Gas Turbine Powerplant	575	203	
E63	Fuel Cells	106	41	
E64	Light Water Reactor	35,916	10,980	1
E65	High-Temperature Gas Reactor	53,156	18,582	1
E66	Fast Breeder Reactor - LMFBR	45,973	10,980	1
E67	Dam and Hydroelectric Powerplant	7,758	465	
E68	Pumped Storage	21,119	1,351	
E69	Geothermal Power Complex	2,715	228	
E70	Solar Space Heating	18,964	6,660	1
E71	Solar Space Conditioning	20,688	7,240	1
T 1	Crude Oil Pipeline - Lower 48	3,519	407	
T 2	Alaskan Oil Pipeline	179,580	24,132	6
T 3	Oil Tanker	0	0	
T 4	Oil Barge	0	0	
T 5	Oil Tank Truck	0	0	
T 6	Products Pipeline	859	75	
T 7	Hot Oil Pipeline	796	60	
T 8	Refined Products Bulk Station	461	45	
T 9	Rail Line	2,457	144	
T10	Mixed Train	0	0	
T11	Coal Unit Train	0	0	
T12	Coal Slurry Pipeline	3,457	453	
T13	Coal Slurry Preparation	2,828	603	
T14	Coal Slurry Dewatering	1,990	151	
T15	Coal Barge	0	0	
T16	Coal Truck	0	0	
T17	Gas Pipeline - Lower 48	3,520	407	
T18	Gas Distribution Facilities	2,242	196	
T19	Alaskan Gas Pipeline	141,848	20,512	4
T20	LNG Tanker	0	0	
T21	230 kVAc Transmission Line	6,405	1,110	
T22	345 kVAc Transmission Line	7,814	1,544	

---

500 kVac Transmission Line	12,234	2,413	51,929
765 kVac Transmission Line	15,116	2,992	70,840
+ 400 kVdc Transmission Line	12,938	2,317	55,339
Electricity Distribution - Aerial Lines	1,071	212	4,703
Electricity Distribution - Underground Lines	1,746	350	1,020

(1) Accuracy of information is seldom greater than three significant figures.

(2) May not add due to rounding.

Escalation in the Costs of Manpower, Materials and Equipment Needed for Energy Facilities. Bechtel (1977).

<u>Labor Category</u>	<u>Person-Hours</u>	<u>Person</u>
Manufacturing	142,593	
Onsite Labor		
Site Preparation	2,000	
Transportation	951	
Assembly and Erection	9,494	
Foundation	<u>4,444</u>	
Onsite Subtotal	16,889	
Total	159,482	

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<sup>a</sup>Using 1,920 hours/person-year.

SOURCE: Lockheed Aircraft Corporation, Wind Mission Analysis Study  
ERDA (Draft Report, LR-27611, 1976).

t incorporate solar technologies and conservation measures into the I-O network. These include:

- o Sector-Specific Output and Employment Impacts of a Solar Space and Heating Industry, by H. C. Peterson, Utah State University, Logan, (1977). This study augments the direct requirements matrix of the I-O table to include the purchase requirements of an industry which manufactures solar collectors and one which installs complete solar space and water heating systems.

Available from: National Technical Information Service (NTIS)  
U.S. Department of Commerce  
Springfield, Virginia 22161

- o The Long Island Jobs Energy Study. Council on Economic Priorities (April 1979 FINAL DRAFT). This study develops a "bill of goods" for solar hot water systems, a nuclear powerplant and a variety of residential conservation measures. The bill of goods is identified in terms of SIC sectors, and can be readily applied to the BLS I-O models.

Contact: Steven Buchsbaum  
Council on Economic Priorities  
84 5th Avenue  
New York, New York 10011  
212/691-8550

- o Labor and Net Energy Effects of a National Ceiling Insulation Program by Charlotte Ford, Center for Advanced Computation, University of Illinois, Urbana, Illinois (September 1978). This study develops a bill of goods for cellulose ceiling insulation (see appendix B).

Contact: Charlotte Ford  
Center for Advanced Computation  
University of Illinois  
Urbana, Illinois 61801  
217/333-3242

solar systems (hot water, hot water/space heating, hot water/space heating/absorption cooling, and auxiliary). The bill of goods is tailored to the national BLS I-O model.

Contact: Jerry Lawry  
Science Applications, Inc.  
JRB Associates  
8400 Westpark Drive  
McLean, Virginia 22102  
202/821-4325

- o Energy, Employment, and Environmental Impacts of Accelerated Innovation in Conservation and Solar Technologies in Buildings. Steven C. Shirish Mulherkar, Jay Schwam, Department of Energy and Environmental Sciences, Brookhaven National Laboratory (PRELIMINARY REPORT, 1978). This report develops a "bill of goods" for conservation and solar technologies in residential/commercial buildings. The bill of goods is identified in terms of BNL I-O Sectors.

Contact: David Kline  
Project Monitor  
U.S. Department of Energy  
Room 2220  
20 Massachusetts Avenue, NW.  
Washington, D.C. 20545  
202/376-4827

- o Analysis of the California Energy Industry. Energy and Environmental Sciences Division, Lawrence Berkeley Laboratory (January 1977). This study develops a bill of goods for passive solar housing construction (additional insulation and double-glazed window units), delamping in commercial buildings, retrofit ceiling insulation, wind turbine generators, solar thermal electric powerplants, and systems to convert municipal solid waste to energy.

Contact: Jayant Sathaye  
Lawrence Berkeley Laboratory  
University of California  
Berkeley, California  
415/451-6292

1.

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- (1) Tables C-1 and C-2 present the various energy supply and transportation facilities contained in the Bechtel Energy Supply Planning Model.
- (2) Table C-3 presents the industrial groupings used in the Bureau Economic Analysis REIS, with Standard Industrial Classification Codes (SIC).
- (3) Table C-4 presents the sectoral classification of the BNL I-O and alignment with other classification systems. The attachment to this table describes the energy sectors in greater detail.
- (4) Table C-5 presents sector descriptions of the RIMS state/census multipliers.
- (5) Table C-6A presents the economic sectors of the REAP I-O model corresponding SIC codes.
- (6) Tables C-6B to C-6D display the REAP project data for three types of energy supply: export mine, electric plant and SNG plant.
- (7) Table C-7 presents the sectoral classification of the BLS I-O with corresponding SIC groups, and projected 1985 employment ratios.
- (8) Table C-8 presents the economic sectors of the RSRI I-O model corresponding SIC codes.
- (9) Table C-9 presents the sectoral classification of the INFORUM and corresponding SIC codes.

2. On-shore Secondary Oil Recovery
3. On-shore Enhanced Oil Recovery
4. Off-shore Oil Recovery
5. North Alaskan Oil Recovery
6. High-Gasoline Refinery
7. Low-Gasoline Refinery
8. Heavy Fuel Oil Gasification
9. Naphtha Gasification
10. Crude Oil Stockpile
11. Alaskan Oil Export
12. Off-shore Crude Oil Import
13. On-shore Oil Import
14. Surface Oil Shale Mine
15. Underground Oil Shale Mine
16. In SITU Shale Oil Recovery
17. Oil Shale Retorting and Upgrading
18. Shale Oil Upgrading

20. On-Shore Enhanced Gas Recovery
21. Off-Shore Gas Recovery - Low
22. North Alaskan Gas Recovery
23. Coal Mine Degasification
24. Alaskan LNG Export
25. LNG Import
26. Natural Gas Stockpile

#### Coal

27. Underground Eastern Coal Mine
28. Surface Eastern Coal Mine
29. Surface Western Coal Mine
30. Underground Western Coal Mine
31. Coal Gasification - High Btu
32. Coal Gasification - Low and Medium Btu
33. Coal Gasification - Methanol
34. Coal Liquefaction - Heavy Fuel
35. Coal Solvent Refining
36. Coal Liquids Refinery

1. Underground Uranium Mine
2. Uranium Mill
3. Uranium Conversion
4. Uranium Enrichment
5. Light Water Reactor Fuel Fabrication - without Plutonium Recycle
6. Light Water Reactor Fuel Fabrication - with Plutonium Recycle
7. High Temperature Gas Reactor Fuel Fabrication
8. Fast Breeder Reactor Fuel Fabrication
9. Light Water Reactor Spent Fuel Reprocessing
10. High Temperature Gas Reactor Spent Fuel Reprocessing
11. Fast Breeder Reactor Spent Fuel Reprocessing
12. High-Level Waste Disposal
13. Solid Waste Collection/ Separation Plant

52. High Temperature Reactor

53. Fast Breeder Reactor

#### Utilities

54. Oil-Fired Power Plant

55. Reconversion of Oil Plant to Coal

56. Coal Fired Power Plant - Low Btu Coal

57. Coal Fired Power Plant - High Btu Coal

58. Coal/Waste Power Plant - Low Btu Coal

59. Coal/Waste Power Plant - High Btu Coal

60. Sulfur Oxide Removal

61. Low/Intermediate Btu Gas Fired Plant

62. High Btu Gas Fired Plant

63. Conversion of Gas Plant to Coal

64. Combined Cycle Power Plant

65. Gas Turbine Power Plant

66. Fuel Cell Power Plant

67. Demand Hydroelectric Power

68. Pumped Storage

69. Secondary Power Complex

70. Solar Space Heating

71. Solar Space Conditioning

72. Geopressed Gas Recovery

73. Coal Solvent Refining

74. Fluidized Bed (Atoms) Power Plant

- |                                 |                               |
|---------------------------------|-------------------------------|
| . Alaskan Oil Pipeline          | 22. 345 kVac Transmission Lin |
| . Oil Tanker                    | 23. 500 kVac Transmission Lin |
| . Oil Barges                    | 24. 765 kVac Transmission Lin |
| . Oil Tank Truck                | 25. 400 kVac Transmission Lin |
| . Products Pipeline             | 26. Electricity Distribution  |
| . Hot Oil Pipeline              | Aerial Lines                  |
| . Refined Products Bulk Station | 27. Electricity Distribution  |
| . Rail Line*                    | Underground Lines             |

al

- . Mixed Train<sup>+</sup>
- . Coal Unit Train
- . Coal Slurry Pipeline
- . Coal Slurry Preparation
- . Coal Slurry Dewatering
- . Coal Barges
- . Coal Truck

e

- . Gas Pipeline
- . Gas Distribution Facilities
- . Alaskan Gas Pipeline
- . LNG Tanker

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ail line applies to a general track of line which could be used to transport both energy and non-energy supplies. It is not limited to the transportation of oil.

mixed train typically transports coal and other energy resources.

Agriculture.....	01, 07.
Forestry and fisheries.....	08, 09.
Mining:	
Metal.....	10.
Coal.....	11, 12.
Crude petroleum and natural gas.....	13.
Nonmetallic, except fuels.....	14.
Contract construction.....	15-17.
Manufacturing:	
Food and kindred products.....	20.
Textile mill products.....	22.
Apparel and other fabric products.....	23.
Lumber products and furniture.....	24.25.
Paper and allied products.....	26.
Printing and publishing.....	27.
Chemicals and allied products.....	28.
Petroleum refining.....	29.
Primary metals.....	33.
Fabricated metals and ordnance.....	34.19.
Machinery, excluding electrical.....	35.
Electrical machinery and supplies.....	36.
Motor vehicles and equipment.....	371.
Transportation equipment, excluding motor vehicles.....	37 except 371.
Other manufacturing.....	21, 30-32, 38,
Transportation, communications and public utilities:	
Railroad transportation.....	40.
Trucking and warehousing.....	42.
Other transportation and services.....	41, 44, 47.
Communications.....	48.
Utilities (electric, gas, sanitary).....	49.
Wholesale and retail trade.....	50, 52-57, 59.
Finance, insurance and real estate.....	60-67.
Services:	
Lodging places and personal services.....	70, 72.
Business and repair services.....	73, 75, 76.
Amusement and recreation services.....	78, 79.

Government:

Civilian government:

Federal Government.....	91 except Fed. military.
State and local government.....	92, 93.
Armed forces.....	Part of 91.

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SOURCE: Executive Office of the President, Bureau of the  
Budget, Standard Industrial Classification Manual,  
1967.

1	Coal	1	7	7	7
2	Crude Oil	2	8	8	8
	Crude Gas				
3	Shale Oil	-	-	-	-
4	Methane from coal	3	-	-	-
5	Coal liquefaction	-	-	-	-
6	Refined oil products	4	31.01	part 31	part 41
7	Pipeline gas	5	68.02	68.2	93
8	Coal combined cycle electric	-	-	-	-
9	Other fossil electric	6	68.01		
			78.02		
			79.02		
10	LWR electric	7	68.01		
			78.02		
			79.02		92
				68.1	part 10
11	HTGR electric	-	-		part 10
	Hydroelectric	8	68.01		
			78.02		
			79.02		
12	Geothermal	-	-	-	-
	Solar electric	-	-	-	-
	Solar direct	-	-	-	-
<hr/>					
13	Ore reduction feedstocks	9	-	-	-
14	Chemical feedstocks	10	-	-	-
15	Motive power	11	-	-	-
16	Process heat	12	-	-	-
17	Water heat	13	-	-	-
18	Space heat	14	-	-	-
19	Air-conditioning	15	-	-	-
20	Electric power	16	-	-	-
<hr/>					
21	Livestock and livestock products	17	1	1	1
22	Other agricultural products	18	2	2	2



agriculture, forestry and fishing services	20	4	4	4	4
fuels and ferroalloys ores mining	21	5	5	5	5
ferrous metal ores mining	22	6	6	6	6
stone and clay mining, quarrying	23	9	9	9	10
chemicals and fertilizer mineral mining	24	10	19	10	11
construction, residen- tial buildings		11.01	11.1	11	12
construction, non- residential buildings		11.02	11.2	12	13
construction, public utilities	25	11.03	11.3	13	14
construction, highways		11.04	11.4	14	15
construction, all other		11.05	11.5	15	16
maintenance and repair construction, residential	26	12.01	12.1	16	17
maintenance and repair construction, all other		12.02	12.2	17	
leather and accessories	27	13	13	18	18
leather and kindred products	28	14	14	19	20
leather goods manufacturers	29	15	15	20	21
wide and narrow fabrics, textile and thread mills	30	16	16	21	22
textile goods and floor coverings	31	17	17	22	23
textile apparel	32	18	18	23	24
textile fabricated textile products	33	19	19	24	26

	except containers	34	20	20	29
44	Wooden containers	35	21	21	26
45	Household furniture	36	22	22	27
<hr/>					
46	Other furniture and fixtures	37	23	23	28
<hr/>					
47	Paper and allied products			24.1	29
	except containers and boxes	38	24	24.2	30
				24.3	31
48	Paperboard containers and boxes	39	25	25	32
49	Printing and publishing	40	26	26	33
<hr/>					
50	Chemicals and selected chemical products	41	27	27.1	34
				27.2	35
				27.3	36
<hr/>					
51	Plastics and synthetic materials	42	28	28.1	37
				28.2	38
52	Drugs, cleaning and toilet preparations	43	29	29	39
53	Paints and allied products	44	30	30	40
54	Paving mixtures and blocks	45	31.02	part 31	part 41
55	Asphalt felts and coatings	46	31.03	part 31	part 41
<hr/>					
56	Rubber and miscellaneous plastics products	47	32	32.1	42
				32.2	43
				32.3	44
57	Leather tanning and industrial leather products	48	33	33	45
58	Footwear and other leather products	49	34	34	46
59	Glass and glass products	50	35	35	47
60	Stone and clay products	51	36	36	48

Manufacturing	52	37	37	49	49-
Primary non-ferrous metals			38.1	50	51-
Manufacturing	53	38	38.2	51	51-
			38.3	52	
Oil containers	54	39	39	53	58
Engineering, plumbing and fabricated structural metal products	55	40	40	54	59-
Power machine prod., bolts, nuts, etc. & metal stampings	56	41	41	55	61
<hr/>					
For fabricated metal products	57	42	42	56	62
Engines and turbines	58	43	43	57	63
Machinery	59	44	44	58	64
Construction, mining, oil field machinery, equipment	60	45	45	59	65
Materials handling machinery and equipment	61	46	46	60	66
<hr/>					
Powerworking machinery and equipment	62	47	47	61	67
Special industry machinery and equipment	63	48	48	62	68
General industrial machinery and equipment	64	49	49	63	69
Machine shop products	65	50	50	64	70
Office, computing and counting machines	66	51	51	65	71-
<hr/>					
Office industry machines	67	52	52	66	73
Trans. & dist. eq. & rec. industry apparatus	68	53	53.1	67	74
			53.2	68	75

	communications equipment	71	56	56	71
81	Electronic components and accessories	72	57	57.1 57.2 57.3	72 73 74
82	Miscellaneous elec. machinery, equipment & supplies	73	58	58	75
83	Motor vehicles and equipment	74	59	59	76
84	Aircraft and parts	75	60	60	77
85	Other transportation equipment	76	61	61	78
86	Professional, scientific & controlling inst. & supp.	77	62	62	79
87	Optical, opthalmic, & photographic equip. & supplies	78	63	63	81
88	Miscellaneous manufacturing	79	64	64	82
89	Railroads and related services	80	65.01	65.1	83
90	Local, urban and inter-urban highway pass. trans.	81	65.02 79.01	65.2	84 part 10
91	Motor freight transportation and warehousing	82	65.03	65.3	85
92	Water transportation	83	65.04	65.4	86
93	Air transportation	84	65.05	65.5	87
94	Pipeline transportation	85	65.06	65.6	88
95	Transportation services	86	65.07	65.7	89
96	Communications except radio & television broadcasting	87	66	66	90

and sanitary services	89	68.03	68.3	94	103
sale and retail trade	90	69	69	95	104
ce and insurance	91	70	70	96	106
estate & rental	92	71	71	97	108
s & lodging; pers. & air serv., except auto					
air	93	72	72	98	110
ness services	94	73	73	99	112
mobile repair & ices	95	75	75	101	115
ements	96	76	76	102	116
cal, educ., services					
on-profit inst.	97	77	77	103	118
ral Government erprises	98	78.01 78.04	- -	part 104	122 124
e and local govern- t enterprises	99	79.03	-	part 105	part 1
ness travel, enter- nment & gifts	100	81	-	107	128
ce supplies	101	82	-	108	129
arch & development	-	74*	-	100	-
s imports	-	80	-	106	126
p, used and second d goods	-	83	-	109	130
rnment industry	-	84	-	-	131
of world industry	-	85	-	-	132
eholds	-	86	-	-	133
ntory valuation	-				
ustment	-	87	-	-	134

ed as a separate sector by BEA in the 1963 and 1967 studies.

Code: BNL 110 - Brookhaven National Laboratory 110 sector version  
BNL 101 - Brookhaven National Laboratory 101 sector version  
BEA - Bureau of Economic Analysis, U.S. Dept. of Commerce  
Battelle - Battelle Memorial Institute; used in An "Ex Ante"  
Capital Maxtrix for the United States, 1970-1975  
A. Carter- Professor Ann Carter, Brandeis University  
BLS - Bureau of Labor Statistics, U.S. Dept. of Labor  
DRI 18 - Data Resources, Inc., 18 sector interindustry model

The first 12 sectors of the I-O are energy supply/conversion sectors that transform basic energy resources into usable (product) forms of energy for meeting final, end-use demand. They depict actual, physical conversion processes and are defined below.

Coal. The coal sector produces raw coal as it comes from the mine. Its total output is measured in Btu's of raw coal. It is assumed that sectors using this coal do their own crushing and cleaning.

Crude Oil and Gas. This sector's total output is the summation of Btu's of crude oil at the wellhead and Btu's of associated and nonassociated gas that are produced domestically. As an accounting convenience, refining losses for domestic gas and refining losses for both imported and domestic crude oil are represented by the diagonal A-matrix coefficient for this sector. This permits energy transfer from the crude oil and gas sector to the refined oil products sector to be measured by Btu's of refined oil products. It also permits energy transfer to the pipeline gas sector to be measured by Btu's of processed gas.

Shale Oil. The shale oil sector produces a crude oil substitute. Its total output is measured in terms of Btu's of crude oil. As an accounting convenience, refining losses are represented by the diagonal A-matrix coefficient for this sector and this sector actually transfers Btu's of refined oil products to the refined oil products sector.

Methane from Coal. This sector produces a high Btu, pipeline-quality synthetic gas from coal by the HYGAS process. The coal input is considered as coal, the same unit of measure as the output of the coal sector. The synthetic gas is a direct substitute for processed natural gas, and all of it is transferred to the pipeline gas sector.

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Whether or not one accounts for energy conversion or distribution losses is immaterial as long as one is not formulating the I-O itself as an optimization problem. What is crucial, however, is the unit of measurement adopted for total energy (total domestic production) from each energy supply sector. This measurement must correspond with the units used to renormalize I-O coefficient columns. The units for the energy sectors from dollars of input per dollar of output to dollars of input per Btu of output.

via coal liquefaction, new costs and conversion efficiencies have been calculated and inserted into BESOM.

6. Refined Oil Products. This sector refines all imported and domestic crude oil, domestic shale oil, and domestic liquefied coal. Its output is measured by Btu's of refined petroleum products, and imports of refined oil are not included in the measure of domestic production.

7. Pipeline Gas. This sector, in essence, distributes high Btu, pipeline-quality gas, and total output is measured by Btu's of process gas produced domestically. Total output does not include imported pipeline gas from Canada or imported LNG, substitutes for that produced domestically. Consumption of gas by pipeline pumping stations is accounted for by a coefficient in the diagonal A-matrix entry for this sector. Transfers to other sectors are therefore measured by Btu's of delivered gas at the point of utilization.

8. Coal Combined-Cycle Electric. This sector produces electricity from combined low-Btu coal gasification and COGAS generation processes. Total output is measured by Btu's of generated electricity. Transmission and distribution losses are tabulated in the diagonal A-matrix entry for this sector, and a contribution to all other sectors is measured by Btu's of distributed electricity. Conventions adopted for all of the electric generation sectors.

9. Other Fossil Electric. This sector combines electricity produced from conventional coal-fired boilers, oil-fired boilers, gas-fired boilers, oil-fired gas turbines, oil-fired steam electric combined cycle, and other total energy systems.

10. LWR Electric. This sector produces electricity from light water reactors.

11. HTGR Electric. This sector produces electricity from high-temperature gas-cooled reactors.

12. Hydroelectric. This sector combines electricity production from (1) hydroelectric generation plants; (2) geothermal steam electric-generation plants; (3) pumped storage plants; and (4) solar electric central installations. Electrical transmission losses in the diagonal element of the A-matrix are represented for the first two and the last electric generation methods for pumped storage.



13. Ore Reduction Feedstocks, ORF. This sector distributes coke for reduction purposes.

14. Chemical Feedstocks, CF. This sector distributes feedstocks for chemical industries in the raw form used by those industries such as naphtha, as well as lubricants and greases used by all industries.

15. Motive Power, MP. This sector's output is measured in terms of horsepower available at a drive shaft for transport purposes regardless of the fuel used to provide that power. Electric rail transport is not included, however.

16. Process Heat, PH. This sector supplies all heating requirements including industrial process heat, cooking heat, and clothes drying.

17. Water Heat, WH. The output of this sector is measured in terms of Btu's of heat added to water for any purpose other than steam for process or space heat.

18. Space Heat, SH. The output of this sector is measured in terms of Btu's of heat added to a building regardless of fuel or type of heating system.

19. Air Conditioning, AC. This sector's output is Btu's of heat removed from the air being conditioned.

20. Electric Power, EP. This sector's output includes all electric power for substitutable uses of transmitted and distributed electricity such as lighting, appliances, other electric drive, industrial electrolysis, etc. Electricity used for motive power in electric rail and mass transit systems is not included in this sector.

A. 16-sector aggregation includes:

1. Agriculture
2. Non-fuel mining
3. Coal mining
4. Crude petroleum and natural gas
5. Chemicals manufacturing
6. Petroleum refining
7. Motor vehicle manufacturing
8. Other manufacturing
9. Transportation
10. Sanitary services, communications, water
11. Electric utilities
12. Gas utilities
13. Trade
14. Finance, insurance, real estate
15. Services
16. Construction

B. 103-sector aggregation includes:

1. Dairy farm products, poultry and eggs	0132, 0133, 0134, pt. 014
2. Meat animals and miscellaneous livestock products	0135, 0136, 0139, pt. 014 0193, pt. 0729
3. Cotton	0112, pt. 014
4. Food feed grains and grass seeds	0113, pt. 0119, pt. 014
5. Forest, greenhouse, and nursery products	0192, pt. 014
6. Forestry and fishery products	074, 081, 082, 084, 086
7. Other crops and services	pt. 0114, 0122, 0123 pt. 0119, pt. 0113 pt. 014, 071, 0723, 073 pt. 0729, 085, 098

#### ining

8. Metal mining	10
9. Coal mining	11, 12
0. Crude petroleum and natural gas	131, 132
1. Stone and clay mining and quarrying	141, 142, 144, 145, 148, 149
2. Chemicals and fertilizer mineral mining	147

#### onstruction

3. Residential buildings	pt. 15, pt.16, pt.17, pt.65
4. Non-residential buildings	pt. 15, pt. 17

15. New electric utility facilities	pt. 16, pt.
16. New gas utility facilities	pt. 16, pt.
17. New petroleum pipelines	pt. 16, pt.
18. New local transit facilities	pt. 16, pt.
19. New highways	pt. 16, pt.
20. New oil and gas wells	pt. 138
21. New oil and gas exploration	pt. 138
22. Maintenance and repair of oil and gas wells	pt. 138
23. All other construction	pt. 15, pt.

#### Manufacturing

24. Meat products	201
25. Dairy products	202
26. Canned, cured, and frozen products	203
27. Grain mill products	204
28. Bakery products	205
29. Beverages	208
30. Miscellaneous food products	206, 207, 20
31. Textile mill products	22
32. Apparel and other fabric products	23

33. Lumber products	24
34. Furniture and fixtures	25
35. Paper mills	262
36. Paper products	26 (excl. 262)
37. Printing and publishing	27
38. Industrial inorganic and organic chemicals	281 (excl. 28195)
39. Plastic materials and resins	2821
40. Synthetic rubber	2822
41. Other plastics and synthetics	2823, 2824
42. Drugs, cleaning and toilet preparations	283, 284
43. Paints and allied products	285
44. Agricultural chemicals	287
45. Carbon black	2895
46. Miscellaneous chemical products	286, 289 (excl. 2895)
47. Petroleum refining	2911, 299
48. Paving mixtures and blocks	2951
49. Asphalt felts and coatings	2952
50. Rubber	30

51. Glass and glass products	321, 322, 323
52. Cement, hydraulic	324
53. Clay	325
54. Concrete, lime, and gypsum	327
55. Other stone and clay products	326, 328, 329
56. Primary aluminum	3334, 28195
57. Aluminum rolling and drawing	3352
58. Primary iron and steel manufacturing	331, 332, 339 (exc.
59. Other primary metal manufacturing	333, 334, 335, 336 (excl. 3334, 3352)
60. Fabricated structural steel	3441
61. Other fabricated metals, ordnance	34, 19 (excl. 3441
62. Engines and turbines	351
63. Farm machinery	352
64. Construction and materials handling	353
65. Metal working machinery	354
66. Special industrial machinery	355
67. General industrial machinery	356
68. Office and computing machinery	357

69. Service and miscellaneous machinery, excluding electrical	358, 359
70. Carbon and graphic products	3624
71. Electrical apparatus and motors	361, 362 (excl. 3624)
72. Household appliances	363
73. Electrical lighting and wiring equipment	364
74. Communications equipment	365, 366
75. Electronic components	367
76. Batteries and miscellaneous electrical equipment	369
77. Motor vehicle and equipment	371
78. Aircraft and parts	372
79. Other transportation equipment	37 (excl. 371, 372)
80. Instruments and clocks	381, 382, 384, 387
81. Photographic equipment	383, 385, 386
82. Other manufacturing	21, 31, 39

Transportation, Communications, Public Utilities

83. Railroads	40, 474
84. Trucking and warehousing	42, 473
85. Air transportation	45

86.	Highway passenger transportation	41
87.	Water transportation	44
88.	Transportation services	47 (excl. 473, 474)
89.	Pipeline transportation	46
90.	Communications	481, 482
91.	Radio and TV broadcasting	483
92.	Electric utilities	491, pt. 493
93.	Gas utilities	492, pt. 493
94.	Water and sanitary services	494, 495, 496, 497
<u>Wholesale and Retail Trade</u>		
95.	Wholesale and retail trade	50, 52-59, 7396, p
<u>Finance, Insurance, Real Estate</u>		
96.	Finance, insurance	60-67 (excl. 65)
97.	Real estate	65 (excl. pt. 6561)
<u>Services</u>		
98.	Hotel and lodging places	70
99.	Auto repair and services	75
100.	Personal and repair services	72, 76 (excl. 7692 and pt. 7699)



- 101. Business serivces 73 (excl. 7396), 7692, 7694, pt. 7699
- 102. Amusement and recreation services 78, 79
- 103. Professional services 80, 81, 82, 84, 86, 89 (excl. 8099)

1. Agr., Livestock	Group 013 - Livestock
2. Agr., Crops	All of Major Group 01 - Agricultural Production, Except Group 013 - Livestock
3. Coal Mining	Major Group 12 - Bituminous Coal and Lignite Mining
4. Contract Construction	Division C - Contract Construction Groups 15, 16, and 17)
5. Transportation	All Division E - Transportation, Com- munications, Electric, Gas, and Sanitary Services, Except Major Groups 48 and 49
6. Communication and Utilities	Major Group 48 - Communication and Group 49 - Electric, Gas, and Sanitary Services (Except Industry No. 491)
7. Processing and Misc. Manufacturing <sup>b</sup>	Major Group 50 - Wholesale Trade and Group 20 - Food and Kindred Products Manufacturing
8. Retail Trade	All of Division F - Wholesale and Retail Trade, Except Major Group 50 - Wholesale Trade
9. Finance, Insurance, and Real Estate	Division G - Finance, Insurance, and Estate
10. Business and Personal Services	All Division H - Services, Except Major Groups 80, 81, 82, 86, and 89
11. Professional and Social Services	Major Group 80 - Medical and Other Services, Major Group 81 - Legal Services, Major Group 82 - Educational Services, Major Group 86 - Non-profit Membership Organizations, Major Group 89 - Miscellaneous Services
12. Households	Not Applicable
13. Government	Division I - Government

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<sup>a</sup>Executive Office of the President/Bureau of the Budget, Standard Industrial Classification Manual, 1967, U.S. Government Printing Office, Washington, D.C., 1967.

<sup>b</sup>Wholesale trade, although relatively insignificant, is included in Sector 7.

Years of Construction Before Operation Begins	Acres of Farmland Lost	Acres Mined Per Year	Acres of Farmland Taken for Urban Use Per In-Migrant	Tons Mined Per Year	KWH Sold	SNG Sold	Mine Value
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4	200	660	0.563	6,600,000	0	0	\$5,583,6
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## Final Demand Vectors

(\$000 000)

Project Year	Economic Sector:	4	8	12
1		2.77	0.86	0.69
2		2.82	2.91	1.72
3		1.08	1.99	3.41
4		1.65	4.60	4.90
5		0	2.23	6.94
6		0	2.60	7.38
7		0	2.60	7.10
8-25		0	2.60	7.16

## Direct Labor (Man-Years)

Project Year:	1	2	3	4	5-2
Construction (or Temporary):	125	50	125	50	0
Operation (or Permanent):	38	103	145	185	225

Specified by user.

Years of Construction Before Operation Begins	Acres of Farmland Lost	Acres Mined Per Year	Acres of Farmland Taken for Urban Use Per In-Migrant	Tons Mined Per Year	KWH Sold
4	2,986	206.5	0.563	2,800,000	3,250,000,000

Project Year	Economic Sector:	Final Demand Vectors (\$000 000)		
		4	8	12
1		4.24	0.28	2.9
2		12.73	0.85	9.1
3		16.37	1.09	17.2
4		16.98	1.13	25.8
5		9.70	1.82	19.3
6		0.61	1.21	5.0
7		0	2.34	5.8
8-25		0	2.34	5.8

## Direct Labor (Man-Years)

Project Year:	1	2	3	4	5	6
Construction (or Temporary):	225	720	1,500	2,250	1,500	50
Operation (or Permanent):	35	110	190	290	393	448

\*Specified by user.

Acres of Farmland Lost	Acres Mined Per Year	Acres of Farmland Taken for Urban Use Per In-Migrant	Tons Mined Per Year	KWH Sold	SNGL Sold	Mine Value
600	350	0.563	14,000,000	0	91,000,000,000	\$11,844,000

Project Year	Economic Sector:	Final Demand Vectors (\$000,000)		
		4	8	12
1		1.20	5.61	7.50
2		4.80	22.43	29.98
3		6.83	31.94	42.70
4		7.21	33.74	45.11
5		0.94	13.21	23.40
6		0.26	11.03	21.17
7		0.17	10.08	22.34
8		0	10.08	20.05
9-25		0	10.08	20.06

## Direct Labor (Man-Years)

Year:	1	2	3	4	5	6	7	8	9
tion (or Temporary):	700	2,800	3,952	4,088	500	106	64		
n (or Permanent):					893	1,001	1,086	1,075	1,000

ed by user.

Sector	Corresponding SIC Group	Empl Rati Mill
1. Livestock and Livestock Products	01-02	
2. Crops and Other Agricultural Products	01-02	
3. Forestry and Fisheries	07-09	
4. Agriculture, Forestry, and Fishery Services	07-09	
5. Iron Ore Mining	101, 106	
6. Copper Ore Mining	102	
7. Other Non-ferrous Metal Ore Mining	103-107 107-109	
8. Coal Mining	11, 12	
9. Crude Petroleum	13	
10. Stone and Clay Mining and Quarrying	141-145, 148, 149	
11. Chemical and Fertilizer Mining	147	
12. New Residential Building Construction	15, 16, 17	
13. New Non-Residential Building Construction	15, 16, 17	

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\*BLS data is not sufficient for computation of employment-ratios for Sectors 12-17.

Sector	Corresponding SIC Group	Ratios (Jobs Per Million Dollars of Output)
New Public Utilities Construction	15, 16, 17	---*
New Highway Construction	15, 16, 17	---*
All Other New Construction	15, 16, 17	---*
Maintenance and Repair Construction	15, 16, 17	---*
Guided Missiles and Space Vehicles	1925	---*
Other Ordnance	19 except 1925	---*
Food Products	20	13.10
Tobacco Manufacturing	21	6.58
Fabric, Yarn, and Thread Mills	221-224, 225, 228	22.50
Miscellaneous Textiles and Floor Construction	227, 229	10.31
Hosiery and Knit Goods	225	20.35
Apparel	23 except 239	40.32
Miscellaneous Fabricated Textiles Products	239	20.15
Logging, Sawmills, and Planing Mills	241, 242	31.14

S data is not sufficient for computation of employment-output  
ratios for Sectors 12-17.

Sector	Corresponding SIC Group	Ratio Mill.
28. Millwork, Plywood, and Other Wood Products	243, 244, 249	
29. Household Furniture	251	
30. Other Furniture	25 except 251	
31. Paper Products	26 except 265	
32. Paperboard	265	
33. Publishing	271-274	
34. Printing	275-279	
35. Chemical Products	281, 286, 289	
36. Agricultural Chemicals	287	
37. Plastic Materials and Synthetic Rubber	2821, 2822	
38. Synthetic Fibers	2823, 2824	
39. Drugs	283	
40. Cleaning and Toilet Preparations	284	
41. Paint	285	
42. Petroleum Products	29	
43. Rubber Products	30 except 307	



		Corresponding	Ratios (Jobs Per
Sector		SIC Group	Million Dollars Output)
4.	Plastic Products	307	16.73
5.	Leather, Footwear, and Leather Products	31	60.62
6.	Glass	321-323	31.25
7.	Cement, Clay, and Concrete Products	324, 325, 327	29.21
8.	Miscellaneous Stone and Clay Products	326, 328, 329	35.54
9.	Blast Furnaces and Basic Steel Products	331	19.28
0.	Iron and Steel Foundries and Forgings	332, 3391, 3399	34.48
1.	Primary Copper Metals	3331	4.26
2.	Primary Aluminum	3334	5.96
3.	Other Primary and Secondary Non-Ferrous Metal	3332, 3333, 3339, 334	5.99
4.	Copper Rolling and Drawing	3351	13.89
5.	Aluminum Rolling and Drawing	3352	14.26
6.	Other Non-Ferrous Rolling and Drawing	3356, 3357	18.22
7.	Miscellaneous Non-Ferrous Metal Products	336, 3392	42.67

		Corresponding	Ratio of Million
Sector		SIC Group	Out
58.	Metal Containers	341, 3491	16
59.	Heating Apparatus and Plumbing Fixtures	343	24
60.	Fabricated Structural Metal	344	30
61.	Screw Machine Products	345, 346	47
62.	Other Fabricated Metal Products	342, 347-349 except 3491	27
63.	Engines, Turbines, and Generators	351	13
64.	Farm Machinery	352	19
65.	Construction, Mining, and Oilfield Machinery	3531-3533	25
66.	Material Handling Equipment	3534-3537	22
67.	Metalworking Machinery	354	34
68.	Special Industry Machinery	355	26
69.	General Industrial Machinery	356	21
70.	Machine Shop Products	359	56
71.	Computers and Peripheral Equipment	3573-3574	21

Sector		Corresponding SIC Group	Ratios (3) Million I Outp
72.	Typewriters and Other Office Machines	357 except 3573, 3574	22
73.	Service Industry Machines	358	10
74.	Electric Transmission Equipment	361	29
75.	Electrical Industrial Apparatus	362	27
76.	Household Appliances	363	15
77.	Electric Lighting and Wiring	364	29
78.	Radio and Television Sets	365	7
79.	Telephone and Telegraph Apparatus	3661	21
80.	Other Electronic Communication Equipment	3662	19
81.	Electronic Components	367	18
82.	Other Electrical Machinery	369	19
83.	Motor Vehicles	371	9
84.	Aircraft	372	25
85.	Ship and Boat Building and Repair	373	35
86.	Railroad and Other Transportation Equipment	374-375	12

Sector	Corresponding SIC Group	Million Of
87. Miscellaneous Transportation Equipment	379	
88. Scientific and Controlling Instruments	381, 382, 387	
89. Medical and Dental Instruments	384	
90. Optical and Ophthalmic Equipment	383, 385	
91. Photographic Equipment and Supplies	386	
92. Miscellaneous Manufactures Products	39	
93. Railroad Transportation	40, 474	
94. Local Transit and Intercity Bus	41	
95. Truck Transportation	42, 473	
96. Water Transportation	44	
97. Air Transportation	45	
98. Other Transportation	46, 47 except 473, 474	
99. Communications, except Radio, TV	48 except 483	
100. Radio and TV Broadcasting	483	

Sector	Corresponding SIC Group	Ratios (Jobs Per Million Dollars of Output)
1. Electric Utilities	491, part 493	11.80
2. Gas Utilities	492, part 493	9.33
3. Water and Sanitary Services	494-497, part 493	18.77
4. Wholesale Trade	50	40.28
5. Retail Trade	52-59	103.39
6. Finance	60-62, 67	55.47
7. Insurance	63, 64	46.39
8. Owner-Occupied Dwellings	SIC not comparable	NA
9. Other Real Estate	65, 66	12.06
10. Hotels and Lodging Places	70	196.83
11. Other Personal Services	72, 76	126.74
12. Miscellaneous Business Services	73 except 731	83.81
13. Advertising	731	7.42
14. Miscellaneous Professional	81, 89 except 892	61.64
15. Automobile Repair	75	34.01
16. Motion Pictures	78	56.87

		Corresponding SIC Group	Million Do Output
117.	Other Amusements	79	100.3
118.	Health Services except Hospitals	80 except 806	97.
119.	Hospitals	806	124.3
120.	Educational Services	82	126.7
121.	Non-Profit Organizations	84, 86, 892	130.4
122.	Post Office	4311	82.8
123.	Commodity Credit Corporation	SIC not comparable	NA
124.	Other Federal Enterprises	SIC not comparable	39.3
125.	State and Local Government Enterprises	SIC not comparable	51.9
126.	Directly Allocated Imports	Dummy Sectors	NA
127.	Transferred Imports	Dummy Sectors	NA
128.	Business Travel, Entertainment, and Gifts	Dummy Sectors	NA
129.	Office Supplies	Dummy Sectors	NA

or e	Absolute Number	Title	1967 SIC
		<u>AGRICULTURE, FORESTRY &amp; FISHERIES</u>	
0	1	Fruit & Vegetable Products	0122, 0123
2	2	Dairy Products	0132
3	3	Poultry Products	0133, 0134
0	4	Other Agricultural Products	011, 0135, 01
			019, 0729 pt,
8	5	Agricultural, Forestry, & Fishery Services	071, 0723, 07
			085, 098
9	6	Forestry & Fishery Products	074, 081, 082
			086, 091
		<u>MINING</u>	
1	7	Dimension Stone	1411
1	8	Crushed & Broken Stone	142
1	9	Sand & Gravel	144
0	10	Mining, not elsewhere classified	145, 148, 149
		<u>CONSTRUCTION</u>	
9	11	Maintenance & Repair Construction Allocator	(NA)
1	12	General Contractors	1511
1	13	Highway & Street Construction	1611
1	14	Heavy Construction	1621
1	15	Special Trade Contractors, not elsewhere classified	172, 174, 175
			177, 178, 179
1	16	Plumbing, Heating, & Air-Conditioning Contractors	1711
1	17	Electrical Contractors	1731

TABLE C-8 (continued)

Sector Code	Absolute Number	Title	1967 SIC
<u>MANUFACTURING</u>			
1900	18	Ordinance & Accessories	19
2011	19	Meat-Packing Plants	2011
2013	20	Sausage & Other Prepared Meat Products	2013
2015	21	Poultry & Small Game Dressing & Packing	2015
2020	22	Creamery Butter & Natural Cheese	2021,
2024	23	Ice Cream & Frozen Desserts	2024
2026	24	Fluid Milk	2026
2031	25	Canned & Cured Sea Foods	2031
2032	26	Canned Specialties	2032
2033	27	Canned Fruits, Vegetables, Preserves, Jams & Jellies	2033
2034	28	Dried & Dehydrated Fruit & Vegetables	2034
2035	29	Pickled Fruits & Vegetables	2035
2036	30	Fresh or Frozen Packaged Fish	2036
2037	31	Frozen Fruits, Fruit Juices, Vegetables & Specialties	2037
2041	32	Flour & Other Grain Mill Products	2041
2042	33	Prepared Feeds for Animals & Fowls	2042
2043	34	Cereal Preparations	2043
2045	35	Blended & Prepared Flour	2045
2046	36	Wet Corn Milling	2046
2051	37	Bread & Other Bakery Products	2051
2052	38	Biscuit, Crackers & Pretzels	2052
2062	39	Cane Sugar Refining	2062
2071	40	Candy & Other Confectionery	2071
2072	41	Chocolate & Cocoa Products	2072



Sector Code	Absolute Number	Title	1967 SIC
<u>MANUFACTURING (Continued)</u>			
2084	44	Wines, Brandy & Brandy Spirits	2084
2085	45	Distilled, Rectified, & Blended Liquors	2085
2086	46	Bottled & Canned Soft Drinks & Carbonated Waters	2086
2087	47	Flavoring Extractions & Flavoring Syrups	2087
2090	48	Food Preparations, not elsewhere classified	2025, 2099
2094	49	Animal & Marine Fats & Oils	2094
2095	50	Roasted Coffee	2095
2096	51	Shortening, Table Oils, Margarine	2096
2097	52	Manufactured Ice	2097
<hr/>			
2111	53	Cigarettes	2111
2121	54	Cigars	2121
2131	55	Tobacco & Snuff	2131
<hr/>			
2211	56	Broad Woven Fabric Mills, Cotton	2211
2221	57	Broad Woven Fabric Mills, Man-Made Fiber & Silk	2221
2231	58	Broad Woven Fabric Mills, Wool	2231
2241	59	Narrow Fabrics & Other Smallwares Mills	2241
2251	60	Women's Full-Length & Knee-Length Hosiery Mills	2251
2252	61	Other Hosiery Mills	2252
2253	62	Knit Outerwear Mills	2253
2254	63	Knit Underwear Mills	2254
2256	64	Knit Fabric Mills	2256
2259	65	Knitting Mills, not elsewhere classified	2259
2261	66	Finishers of Broad Woven Fabrics of Cotton	2261

TABLE C-8 (continued)

bsolute Number	Title	1967 SIC
	<u>MANUFACTURING (Continued)</u>	
67	Finishers of Broad Woven Fabrics of Man-Made Fiber & Silk	2262
68	Dying & Finishing Textiles, not elsewhere classified	2269
69	Woven Carpets & Rugs	2271
70	Tufted Carpets & Rugs	2272
71	Carpets, Rugs, & Mats, not elsewhere classified	2279
72	Yarn Spinning Mills	2281
73	Yarn Throwing, Twisting, & Winding Mills	2282
74	Yarn Mills, Wool, Including Carpet & Rug Yarn	2283
75	Thread Mills	2284
76	Felt Goods, Excluding Woven Felts & Hats	2291
77	Lace Goods	2292
78	Padding & Upholstery Filling	2293
79	Processed Waste & Recovered Fibers & Flock	2294
80	Artificial Leather, Oilcloth, etc.	2295
81	Wool Scouring, Worsted Combing, & Tow-to-Top Mills	2297
82	Cordage & Twine	2298
83	Textile Goods, not elsewhere classified	2299
84	Men's, Youths', & Boys' Suits, Coats, & Overcoats	2311
85	Men's, Youths', & Boys' Shirts, Collars, Nightwear	2321
86	Men's, Youths', & Boys' Underwear	2322

<u>Code</u>	<u>Absolute Number</u>	<u>Title</u>	<u>1967 SIC</u>
		<u>MANUFACTURING (Continued)</u>	
28	89	Work Clothing	2328
29	90	Men's, Youths' & Boys' Clothing not elsewhere classified	2329
31	91	Blouses, Waists, & Shirts	2331
35	92	Dresses	2335
37	93	Suits, Shirts & Coats, Excluding Fur Coats & Raincoats	2337
39	94	Women's, Misses', & Juniors' Outerwear, not elsewhere classified	2339
41	95	Women's, Misses', Children's & Infants' Underwear	2341
42	96	Corsets & Allied Garments	2342
51	97	Millinery	2351
52	98	Men's & Boys' Hats & Caps	2352
51	99	Dresses, Blouses, Waists, & Shirts	2361
53	100	Coats & Suits	2363
59	101	Girls', Children's & Infants' Outerwear, not elsewhere classified	2369
71	102	Fur Goods	2371
81	103	Dresses & Work Gloves, Excluding Knit & All Leather	2381
84	104	Robes & Dressing Gowns	2384
85	105	Raincoats & Other Waterproof Outer Garments	2385
86	106	Leather & Sheep-Lined Clothing	2386
87	107	Apparel Belts	2387
89	108	Apparel, not elsewhere classified	2389
91	109	Curtains & Draperies	2391
92	110	Housefurnishings, Excluding Curtains & Draperies	2392
92	111	Textile Rags	2393
94	112	Canvas Products	2394

TABLE C-8 (continued)

<u>bsolute Number</u>	<u>Title</u>	<u>1967 SIC</u>
<u>MANUFACTURING (Continued)</u>		
113	Pleating, Decorative & Novelty Stitching & Tucking	2395
114	Apparel Findings & Related Products	2396
115	Schiffli Machine Embroideries	2397
116	Fabricated Textile Products, not elsewhere classified	2399
<hr/>		
117	Sawmills & Planing Mills, General	2421
118	Millwork Plants	2431
119	Prefabricated Wooden Buildings & Structural Members	2433
120	Nailed & Lock Corner Wooden Boxes & Shook	2441
121	Veneer & Plywood Containers, Excluding Boxes & Crates	
122	Cooperage	2411, 2426, 2429,
123	Wood Products, not elsewhere classified	2432, 2442, 2491,
		2499
<hr/>		
124	Wood Household Furniture, Excluding Upholstered	2511
125	Wood Household Furniture, Upholstered	2512
126	Metal Household Furniture	2514
127	Mattresses & Bedsprings	2515
128	Household Furniture, not elsewhere classified	2519
129	Wood Office Furniture	2521

Number

Title

SIC

MANUFACTURING (Continued)

133	Metal Partitions, Shelving, Lockers & Office & Store Fixtures	2542
134	Venetian Blinds & Shades	2591
135	Furniture & Fixtures, not elsewhere classified	2599
<hr/>		
136	Paper Mills, Excluding Building Paper Mills	2621
137	Paperboard Mills	2631
138	Converted Paper & Paperboard Products, not elsewhere classified	2644, 2646, 2649
139	Paper Coating & Glazing	2641
140	Envelopes	2642
141	Bags, Excluding Textile Bags	2643
142	Die Cut Paper & Paperboard; & Cardboard	2645
143	Sanitary Paper Products	2647
144	Folding Paperboard Boxes	2651
145	Set-Up Paperboard Boxes	2652
146	Corrugated & Solid Fiber Boxes	2653
147	Sanitary Food Containers	2654
148	Fiber Cans, Tubes, Drums, & Similar Products	2655
149	Building Paper & Building Board Mills	2661
<hr/>		
150	Newspapers: Publishing, Publishing & Printing	2711
151	Periodicals: Publishing, Publishing & Printing	2721
152	Books: Publishing, Publishing & Printing	2731
153	Book Printing	2732
154	Miscellaneous Publishing	2741
155	Commercial Printing, Excluding Lithographic	2751

TABLE C-8 (continued)

<u>Sector Code</u>	<u>Absolute Number</u>	<u>Title</u>	<u>1967 SIC</u>
<u>MANUFACTURING (Continued)</u>			
2752	156	Commercial Printing, Lithographic	2752
2753	157	Engraving & Plate Printing	2753
2761	158	Manifold Business Forms Manufacturing	2761
2771	159	Greeting Card Manufacturing	2771
2782	160	Blankbooks, Loose-Leaf Binders & Devices	2782
2789	161	Bookbinding & Miscellaneous Related Work	2789
2791	162	Typesetting	2791
2793	163	Photoengraving	2793
2794	164	Electrotyping & Stereotyping	2794
2799	165	Service Industries for the Printing Trades, not elsewhere classified	2799
2813	166	Industrial Gases	2813
2815	167	Cyclic Intermediates, Dyes, Organic Pigments and Cyclic Crudes	2815
2816	168	Inorganic Pigments	2816
2818	169	Industrial Organic Chemicals, not elsewhere classified	2818
2819	170	Industrial Inorganic Chemicals, not elsewhere classified	2819
2821	171	Plastics Materials, Synthetic Resins & Nonvulcanizable Elastomers	2821
2830	172	Drugs	283
2841	173	Soap & Other Detergents	2841
2842	174	Specialty Cleaning, Polishing & Sanitation	

<u>e</u>	<u>Number</u>	<u>Title</u>	<u>SIC</u>
		<u>MANUFACTURING (Continued)</u>	
1	177	Paints, Varnishes, Lacquers, Enamels, & Allied Products	2851
1	178	Gum & Wood Chemicals	2861
0	179	Agricultural Chemicals	2879, 2873, 2
1	180	Fertilizers	2871
1	181	Adhesives & Gelatin	2891
2	182	Explosives	2892
3	183	Printing Ink	2893
5	184	Carbon Black	
9	185	Chemicals & Chemical Preparations, not elsewhere classified	2899
1	186	Petroleum Refining	2911
1	187	Paving & Mixture & Blocks	2951
2	188	Asphalt Felts & Coatings	2952
2	189	Lubricating Oils & Greases	2992
1	190	Tires & Inner Tubes	3011
1	191	Rubber Footwear	3021
1	192	Reclaimed Rubber	3031
9	193	Fabricated Rubber Products, not elsewhere classified	3069
9	194	Miscellaneous Plastic Products	3079
1	195	Leather Tanning & Finishing	3111
1	196	Industrial Leather Belting & Packing	3121
1	197	Boot & Shoe Cut Stock & Findings	3131
1	198	Footwear, Excluding House Slippers	3141

TABLE C-8 (continued)

<u>Sector Code</u>	<u>Absolute Number</u>	<u>Title</u>	<u>1967 SIC</u>
		<u>MANUFACTURING (Continued)</u>	
3142	199	House Slippers	3142
3161	200	Luggage	3161
3171	201	Women's Handbags & Purses	3171
3172	202	Personal Leather Goods, Excluding Handbags & Purses	3172
3199	203	Leather Goods, not elsewhere classified	3199
3211	204	Flat Glass	3211
3221	205	Glass Containers	3221
3229	206	Pressed & Blown Glass Glassware, not elsewhere classified	3229
3231	207	Glass Products Made of Purchased Glass	3231
3241	208	Cement, Hydraulic	3241
3251	209	Brick & Structural Clay Tile	3251
3253	210	Ceramic Wall & Floor Tile	3253
3255	211	Clay Refractories	3255
3259	212	Structural Clay Products, not elsewhere classified	3259
3261	213	Vitreous China Plumbing Fixtures	3261
3269	214	Pottery Products, not elsewhere classified	3269
3271	215	Concrete Brick & Block	3271
3272	216	Concrete Products, Excluding Block & Brick	3272
3273	217	Ready-Mixed Cement	3273



Sector Code	Absolute Number	Title	
<u>MANUFACTURING (Continued)</u>			
3293	223	Steam & Other Packing & Pipe & Boiler Covering	32
3295	224	Minerals & Earths	32
3296	225	Mineral Wool	32
3297	226	Nonclay Refractories	32
3299	227	Nonmetallic Mineral Products, not elsewhere classified	32
<hr/>			
3312	228	Blast Furnaces, Steel Works, & Rolling Mills	33
3315	229	Steel Wire Drawing & Steel Nails & Spikes	33
3316	230	Cold Rolled Sheet, Strip & Bars	33
3317	231	Steel Pipe & Tubes	33
3321	232	Gray Iron Foundries	33
3323	233	Steel Iron Foundries	33
3330	234	Primary Smelting & Refining of Nonferrous Metals	33
3333	235	Primary Smelting & Refining of Zinc	33
3334	236	Primary Production of Aluminum	33
3341	237	Secondary Smelting Refining & Alloying of Nonferrous Metals	33
3351	238	Rolling, Drawing & Extruding of Copper	33
3352	239	Rolling, Drawing & Extruding of Aluminum	33
3356	240	Rolling, Drawing & Extruding of Other Nonferrous Metals	33
3357	241	Drawing & Insulating of Nonferrous Wire	33
3361	242	Aluminum Castings	33
3362	243	Brass, Bronze, Copper, Copper Base Alloy Castings	33
3369	244	Nonferrous Casting, not elsewhere classified	33

TABLE C-8 (continued)

Factor code	Absolute Number	Title	1967 SIC
<u>MANUFACTURING (Continued)</u>			
390	245	Primary Metal Products, not elsewhere classified	3392, 3399
391	246	Iron & Steel Forgings	3391
<hr/>			
411	247	Metal Cans	3411
421	248	Cutlery	3421
423	249	Hand & Edge Tools, Excluding Machine Tools & Saws	3423
425	250	Hand Saws & Saw Blades	3425
429	251	Hardware, not elsewhere classified	3429
431	252	Enameled Iron & Metal Sanitary Ware	3431
432	253	Plumbing Fixture Fittings & Trim	3432
433	254	Heating Equipment, Excluding Electric	3433
441	255	Fabricated Structural Steel	3441
442	256	Metal Doors, Sash, Frames, Molding & Trims	3442
443	257	Fabricated Plate Work (Boiler Shops)	3443
444	258	Sheet Metal Work	3444
449	259	Architectural & Miscellaneous Metal Work	3446, 3449
451	260	Screw Machine Products	3451
452	261	Bolts, Nuts, Screws, Rivets & Washers	3452
461	262	Metal Stampings	3461
471	263	Electroplating, Plating, Polishing, Anodizing & Coloring	3471
479	264	Coating, Engraving, & Allied Services, not elsewhere classified	3479
481	265	Miscellaneous Fabricated Wire Products	3481
491	266	Metal Shipping Barrels, Drums, Kegs & Pails	3491

TABLE C-8 (continued)

Absolute Number	Title	1967 SIC
<u>MANUFACTURING (Continued)</u>		
269	Collapsible Tubes	3496
270	Metal Foil & Leaf	3497
271	Fabricated Pipe & Fabricated Pipe Fittings	3498
272	Fabricated Metal Products, not elsewhere classified	3499
273	Steam Engines; Steam, Gas, & Hydraulic Turbines; and Steam, Gas, & Hydraulic Turbine Generator Set Units & Other Internal Combustion Engines, not elsewhere classified	3511, 3519
274	Farm Machinery & Equipment	3522
275	Construction Machinery & Equipment	3531
276	Elevators & Moving Stairways	3534
277	Conveyors & Conveying Equipment	3535
278	Hoist, Industrial Cranes & Monorail Systems	3536
279	Industrial Trucks, Tractors, Trailers & Stackers	3537
280	Machine Tools, Metal-Cutting Types	3541
281	Machine Tools, Metal-Forming Types	3542
282	Special Dies & Tools, Die Sets, Jigs & Fixtures	3544
283	Machine Tool Accessories & Measuring Devices	3545
284	Metal-Working Machinery, Excluding Machine Tools	3548
285	Food Products Machinery	3551
286	Textile Machinery	3552
287	Woodworking Machinery	3553
288	Paper Industries Machinery	3554
289	Printing Trades Machinery & Equipment	3555

TABLE C-8 (continued)

or e	Absolute Number	Title	1967 SIC
		<u>MANUFACTURING (Continued)</u>	
29	290	Special Industry Machinery, not elsewhere classified	3559
1	291	Pumps, Air & Gas Compressors & Pumping Equipment	3561
2	292	Ball & Roller Bearings	3562
4	294	Blowers Exhaust & Ventilating Fans	3564
5	294	Industrial Patterns	3565
6	295	Mechanical Power Transmission Equipment, Excluding Ball and Roller Bearings	3566
7	296	Industrial Process Furnaces & Ovens	3567
9	297	General Industrial Machinery & Equipment, not elsewhere classified	3569
3	298	Electronic Computing Equipment	3573
6	299	Scales & Balances, Excluding Laboratory	3576
9	300	Office Machines, not elsewhere classified	3579
1	301	Automatic Merchandising Machines	3581
2	302	Commercial Laundry, Dry Cleaning, & Processing Machines	3582
5	303	Refrigerators, Refrigeration Machinery, Excluding Household, & Complete Air-Conditioning Units	3585
6	304	Measuring & Dispensing Pumps	3586
9	305	Service Industry Machines, not elsewhere classified	3589
9	306	Miscellaneous Machinery, Except Electrical	3599, 3532, 3

Sector Code	Absolute Number	Title	
		<u>MANUFACTURING</u> (Continued)	
3621	310	Motors & Generators	3621
3622	311	Industrial Controls	3622
3623	312	Welding Apparatus	3623
3624	313	Carbon & Graphite Products	3624
3629	314	Electrical Industrial Apparatus, not elsewhere classified	3629
3631	315	Household Cooking Equipment	3631
3633	316	Household Laundry Equipment	3633
3634	317	Electric Housewares & Fans	3634
3635	318	Household Vacuum Cleaners	3635
3639	319	Household Appliances, not elsewhere classified	3639
3642	320	Lighting Fixtures	3642
3643	321	Current-Carrying Wiring Devices	3643
3644	322	Noncurrent-Carrying Wiring Devices	3644
3651	323	Radio & T.V. Receiving Sets, Excluding Communication Types	3651
3652	324	Phonograph Records	3652
3661	325	Telephone & Telegraph Apparatus	3661
3662	326	Radio & T.V. Transmitting, Signaling & Detection Equipment & Apparatus	3662
3672	327	Cathode Ray Picture Tubes	3672
3673	328	Transmitting Industrial & Special Purpose Electron Tubes	3673
3674	329	Semiconductors & Related Devices	3674
3679	330	Electronic Components & Accessories, not elsewhere classified	3679
3690	331	Electrical Machinery Equipment & Supplies, not elsewhere classified	3690,
3691	332	Storage Batteries	3691

TABLE C-8 (continued)

Code	Absolute Number	Title	1967 SIC
		<u>MANUFACTURING</u> (Continued)	
93	333	X-Ray Apparatus and Tubes	3693
94	334	Engine Electrical Equipment	3694
11	335	Motor Vehicles	3711
13	336	Truck & Bus Bodies	3713
14	337	Motor Vehicle Parts & Accessories	3714
15	338	Truck Trailers	3715
21	339	Aircraft	3721
22	340	Aircraft Engines & Engine Parts	3722
29	341	Aircraft Parts, Equipment, not elsewhere classified	3729
31	342	Ship Building & Repairing	3731
32	343	Boat Building & Repairing	3732
42	344	Railroad & Street Cars	3742
91	345	Trailer Coaches	3791
99	346	Transportation Equipment, not elsewhere classified	3799

11	347	Engineering, Laboratory, & Scientific & Research Instruments & Associated Equipment	3811
21	348	Mechanical Measuring & Controlling Instruments	3821
22	349	Automatic Temperature Controls	3822
31	350	Optical Instruments & Lenses	3831
41	351	Surgical & Medical Instruments & Apparatus	3841
42	352	Orthopedic, Prosthetic & Surgical Appliances	3842
43	353	Dental Equipment & Supplies	3843
51	354	Photographic Equipment & Supplies	3861

TABLE C-8 (continued)

Error  
 Code

Absolute  
 Number

Title

1967  
 SIC

MANUFACTURING (Continued)

356	Lapidary Work & Cutting & Polishing Diamonds	3913
357	Silverware & Plated Ware	3914
358	Musical Instruments & Parts	3931
359	Games & Toys	3941
360	Dolls	3942
361	Children's Vehicles, Excluding Bicycles	3949
362	Pens, Pen Points, Fountain Pens, Ball Point Pens, Mechanical Pencils & Parts	3951
363	Lead Pencils, Crayons, Artists' Materials	3952
364	Marketing Devices	3953
365	Carbon Paper & Inked Ribbons	3955
366	Costume Jewelry & Costume Novelties, Excluding Precious Metals	3961
367	Feathers, Plumes, & Artificial Flowers	3962
368	Needles, Pins, Hooks & Eyes, & Similar Notions	3964
369	Brooms & Brushes	3991
370	Signs & Advertising Displays	3993
371	Morticians' Goods	3994
372	Linoleum, Asphalted-Felt-Base, and Other Floor Coverings	3996
373	Manufacturing Industries, not elsewhere classified	3999, 3851, 3963, 3943

TRANSPORTATION, COMMUNICATIONS, ELECTRIC, GAS  
AND SANITARY SERVICES

374

Railroads

011

4011, 4013

TABLE C-8 (continued)

Sector Code	Absolute Number	Title	1967 SIC
<u>TRANSPORTATION, COMMUNICATIONS, ELECTRIC, GAS AND SANITARY SERVICES (continued)</u>			
4150	377	Transportation Services, not elsewhere classified	4020, 413, 4231, 421 422 44 45
4210	378	Trucking, Local & Long Distance	
4220	379	Public Warehousing	
4400	380	Water Transportation	
4500	381	Air Transportation	
<u>Communications</u>			
4811	382	Telephone Communication	4811
4832	383	Radio Broadcasting	4832
4833	384	Television Broadcasting	4833
4890	385	Communication Services, not elsewhere classified	4821,
<u>Utilities</u>			
4911	386	Electric Companies & Systems	4961,
4920	387	Gas Companies & Systems	492 &
4941	388	Water Supply	4941
4990	489	Sanitary & Other Utility Systems, not elsewhere classified	4939,



WHOLESALE TRADE (continued)

394	Paints & Varnishes	5028
395	Chemicals & Allied Products, not elsewhere classified	5029
396	Dry Goods, Piece Goods, & Notions	5033, 5034
397	Apparel & Accessories, Hosiery & Lingerie	5036, 5037
398	Footwear	5039
399	Groceries, General Line	5041
400	Dairy Products	5043
401	Poultry & Poultry Products	5044
402	Confectionery	5045
403	Fish & Sea Foods	5046
404	Meats & Meat Products	5047
405	Fresh Fruits & Vegetables	5048
406	Groceries & Related Products, not elsewhere classified	5049, 5042
407	Farm Products, Raw Materials	505
408	Electrical Apparatus & Equipment, Wiring Supplies, & Construction Materials	5063
409	Electrical Appliances, TV & Radio Sets	5064
410	Electrical Parts & Equipment	5065
411	Hardware	5072
412	Plumbing & Heating Equipment & Supplies	5074
413	Air-Conditioning & Refrigeration Equipment & Supplies	5077
414	Commercial & Industrial Machinery, Equipment, & Supplies	5082
415	Farm Machinery & Equipment	5083
416	Professional Equipment & Supplies	5086
417	Equipment & Supplies for Service Establishments	5087

TABLE C-8 (continued)

Sector Code	Absolute Number	Title	1967 SIC
<u>WHOLESALE TRADE</u> (continued)			
5089	418	Machinery, Equipment, & Supplies, not elsewhere classified	5088,
5091	419	Metals & Minerals, Excluding Petroleum & Scrap	5091
5092	420	Petroleum & Petroleum Products	5092
5093	421	Scrap & Waste Materials	5093
5099	422	Miscellaneous Wholesalers, not elsewhere classified	5094, 5097,
<u>RETAIL TRADE</u>			
5210	423	Lumber & Other Building Materials Dealers	5211
5221	424	Plumbing, Heating, & Air-Conditioning Equipment Dealers	5221
5231	425	Paint, Glass, & Wallpaper Stores	5231
5241	426	Electrical Supply Stores	5241
5250	427	Hardware Stores & Farm Equipment Dealers	525
<hr/>			
5311	428	Department Stores	5311
5331	429	Variety Stores	5331
5342	430	Mail Order Houses & Merchandise Vending Machine Operators	5341
5351	431	Direct Selling Organizations	5351
5399	432	Miscellaneous General Merchandise Stores	5399

TitleSICRETAIL TRADE (continued)

436	Candy, Nut, & Confectionery Stores	5441
437	Retail Bakeries	546
438	Miscellaneous Food Stores, not elsewhere classified	5451, 5499
439	Motor Vehicle Dealers	5511
440	Motor Vehicle Dealers, (used cars only)	5521
441	Tire, Battery, & Accessory Dealers	5531
442	Gasoline Service Stations	5541
443	Miscellaneous Aircraft, Marine & Automotive Dealers	559
444	Men's & Boys' Clothing & Furnishings Stores	5611
445	Women's Ready-to-Wear Stores	5621
446	Women's Accessory & Specialty Stores	5631
447	Children's & Infants' Wear Stores	5641
448	Family Clothing Stores	5651
449	Shoe Stores	5661
450	Miscellaneous Apparel & Accessory Stores, not elsewhere classified	5671, 5681, 56
451	Furniture, Home Furnishings, & Equipment Stores	571
452	Household Appliance Stores	5722
453	Radio, Television, & Music Stores	573
454	Eating Places	5812
455	Drinking Places	5813

TABLE C-8 (continued)

<u>Factor code</u>	<u>Absolute Number</u>	<u>Title</u>	<u>1967 SIC</u>
		<u>RETAIL TRADE (continued)</u>	
912	456	Drug Stores & Proprietary Stores	5912
921	457	Liquor Stores	5921
940	458	Book & Stationery Stores	594
950	459	Sporting Goods Stores & Bicycle Shops	595
971	460	Jewelry Stores	5971
980	461	Fuel & Ice Dealers	598
990	462	Retail Stores, not elsewhere classified	593, 596, 59
		<u>FINANCE, INSURANCE, AND REAL ESTATE</u>	
011	463	Federal Reserve Bank	6011
020	464	Commercial & Stock Savings Banks	602
030	465	Mutual Savings Banks	603
120	466	Savings & Loan Associations	612
190	467	Miscellaneous Financial Institutions	604, 605, 61 614, 615, 61
200	468	Security & Commodity Brokers, Dealers, Exchanges, & Services	62
801	469	Non-Life Insurance Carriers	632 pt, 633, 636, 639
810	470	Life Insurance Carriers	631, 632 pt

<u>Absolute Number</u>	<u>Title</u>	<u>1967 SIC</u>
	<u>SERVICES</u>	
473	Hotel, Personal, & Repair Services	70, 72, 76 (exc. 7694, 7699)
474	Business Services, Excluding Advertising	6541, 73 (exc. 7391) 7694, 7699
475	Advertising Services	81, 89 (exc. 89 731)
476	Research & Development, Educational & Scientific Research Agencies	7391, 8921
477	Automobile Repair, Services & Garages	75
478	Amusement & Recreational Services	78, 79
	<u>MEDICAL, EDUCATIONAL, NON-PROFIT</u>	
479	Hospitals	8061
480	Medical & Health Services, not elsewhere classified	80 (exc. 8061), 0722
481	Elementary & Secondary Schools	8211
482	Institutions of Higher Education	822

TABLE C-8 (continued)

<u>Code</u>	<u>Absolute Number</u>	<u>Title</u>	<u>1967 SIC</u>
		<u>MEDICAL, EDUCATIONAL, NON-PROFIT (continued)</u>	
000	483	Other Educational Services, not elsewhere classified	823, 824, 829
886	484	Non-Profit Membership Organizations, Museums, Art Galleries, Botanical & Zoological Gardens	84, 86
000	485	Private Household Services	88
		<u>GOVERNMENT, HOUSEHOLDS, &amp; MISCELLANEOUS</u>	
000	486	Local Government, Excluding Water Utilities and Education	93
66	487	Office Supplies Allocator	(NA)
22	488	Transportation Services Allocator	(NA)
88	489	Households	(NA)
99	490	Nonclassifiable Industries	9999
		SECTORS WHICH APPEAR ONLY AS ROWS, NOT AS COLUMNS	
11	491	Iron Ores	1011
21	492	Copper Ores	1021

<u>Code</u>	<u>Number</u>	<u>Title</u>	<u>SIC</u>
		<u>GOVERNMENT, HOUSEHOLDS, &amp; MISCELLANEOUS (continued)</u>	
993	497	Titanium Ores	1093
999	498	Metal Ores, not elsewhere classified	1099
100	499	Anthracite Mining	1100
1311	500	Crude Petroleum and Natural Gas	1311
1453	501	Fire Clay	1453
1455	502	Kaolin and Ball Clay	1455
1459	503	Clay and Related Materials, not elsewhere classified	1459
1470	504	Chemical and Fertilizer Minerals	1470
2023	505	Condensed and Evaporated Milk	2023
2044	506	Rice Milling	2044
2061	507	Raw Cane Sugar	2061
2083	508	Malt	2083
2091	509	Cottonseed Oil Mills	2091
2092	510	Soybean Oil Mills	2092
2141	511	Tobacco Stemming and Redrying	2141
2296	512	Tire Cord and Fabric	2296

TABLE C-8 (continued)

Sector Code	Absolute Number	Title	1967 SIC
<u>GOVERNMENT, HOUSEHOLDS, &amp; MISCELLANEOUS (continued)</u>			
* 2442	513	Wirebound Boxes and Crates	2442
* 2611	514	Pulp Mills	2611
* 2812	515	Alkalies and Chlorine	2812
* 2822	516	Synthetic Rubber	2822
* 2823	517	Cellulose Man-Made Fibers	2823
* 2824	518	Synthetic Organic Fibers	2824
* 2833	519	Medicinals and Botanicals	2833
* 2999	520	Petroleum and Coal Products, not elsewhere classified	2999
* 3151	521	Leather Gloves and Mittens	3151
* 3262	522	Vitreous Table and Kitchenware	3262
* 3263	523	Fine Earthenware Food Utensils	3263
* 3264	524	Porcelain Electrical Supplies	3264
* 3313	525	Electrometallurgical Products	3313



<u>Code</u>	<u>Number</u>	<u>Title</u>	<u>SIC</u>
<u>GOVERNMENT, HOUSEHOLDS, &amp; MISCELLANEOUS (continued)</u>			
3572	528	Typewriters	3572
3584	529	Industrial Vacuum Cleaners	part 3589
3632	530	Household Refrigerators and Freezers	3632
3636	531	Sewing Machines	3636
3641	532	Electric Lamps	3641
3671	533	Electron Tubes, Receiving Type	3671
3692	534	Primary Batteries, Dry and Wet	3692
3723	535	Aircraft Propellers and Parts	3723
3741	536	Locomotives and Parts	3741
3751	537	Motocycles, Bicycles and Parts	3751
3851	538	Opthalmic Goods	3851
3871	539	Watches, Clocks and Watchcases	3871
3943	540	Childrens' Vehicles, Excluding Bicycles	3943
6510	541	Real Estate Operators and Lessors	6510
9100	542	Federal Taxes	(NA)
9102	543	U.S. Post Office	(NA)

TABLE C-8 (continued)

<u>Code</u>	<u>Absolute Number</u>	<u>Title</u>	1967 <u>SIC</u>
		<u>GOVERNMENT, HOUSEHOLDS, &amp; MISCELLANEOUS (continued)</u>	
200	544	State Taxes	(NA)
522	545	Scrap Textile Products	(NA)
524	546	Scrap Lumber Products	(NA)
526	547	Scrap Paper Products	(NA)
530	548	Scrap Rubber Products	(NA)
533	549	Scrap Ferrous Metal Products	(NA)
534	550	Scrap Nonferrous Metal Products	(NA)
538	551	Scrap Steel Drums	(NA)
891	552	Net Profit	(NA)
892	553	Capital Allowance	(NA)
893	554	Employee Fringe Benefits	(NA)

The 90-order aggregate sector number, for investment and employment follows the sector title. The 4-digit SIC codes are those used for 1967 census of manufactures. A code ending with a '0' designates entire 3-digit group; a code ending with '00' designates an entire 2-digit group. A minus sign indicates that this SIC is excluded from the sector.

<u>Sector Titles</u>		<u>90-Order</u>	<u>Standard Industrial Classification</u>					
1	Dairy farm products	( 1)	132					
2	Poultry and eggs	( 1)	133					
3	Meat animals, oth livestock	( 1)	135	136	139	193		
4	Cotton	( 1)	112					
5	Grains	( 1)	113					
6	Tobacco	( 1)	114					
7	Fruit, vegetables, oth crops	( 1)	119	120	192			
8	Forestry	( 1)	810	820	840	860	9	
9	Fishery products	( 1)	074					
10	Agr, forestry & fish serv.	( 1)	710	720	730	850	9	
11	Iron ores	( 2)	1010	1060				
12	Copper ore	( 2)	1020					
13	Other non-ferrous ores	( 2)	1030	1050	1090			
14	Coal mining	( 2)	1110	1210				
15	Crude petroleum, nat. gas	( 3)	1310	1320				
16	Empty							
17	Stone and clay mining	( 2)	1410	1420	1440	1450	14	
18	Chemical fertilizer mining	( 2)	1470					
19	New construction	( 4)	1600					
20	Maintenance construction	( 0)	1500					
21	Complete guided missiles	( 5)	1925					
22	Ammunition	( 5)	1929	1960				
23	Other ordnance	( 5)	1910	1930	1940	1950	19	
24	Meat products	( 6)	2010					
25	Dairy products	( 7)	2020					
26	Canned and frozen foods	( 8)	2030					
27	Grain mill products	( 9)	2040					
28	Bakery products	(10)	2050					
29	Sugar	(11)	2060					
30	Confectionery products	(12)	2070					
31	Alcoholic beverages	(13)	2082	2083	2084	2085		
32	Soft drinks and flavorings	(13)	2086	2087				
33	Fats and oils	(14)	2091	2092	2093	2094	20	

Tobacco products	(15)	2110	2120	2130	2140	
Broad and narrow fabrics	(16)	2210	2220	2230	2240	2261
Yarn, thread, finishing	(16)	2269	2280			
Floor coverings	(17)	2270				
Misc textiles	(18)	2290				
Knitting	(19)	2250				
Apparel	(20)	2310	2320	2330	2340	2350
		2380	3992			
Household textiles	(21)	2390				
Logging camps	(22)	2410				
Saw and planing mills	(22)	2420				
Veneer and plywood	(23)	2432				
Millwork and wood products	(23)	2431	2433	2490		
Wooden containers	(24)	2440				
Household furniture	(25)	2510				
Other furniture	(25)	2520	2530	2540	2590	
Pulp mills	(25)	2610				
Paper and paperboard mills	(27)	2620	2630			
Paper products, NEC	(27)	2641	2642	2643	2645	2646
Wall and building paper	(27)	2644	2660			
Paperboard containers	(28)	2650				
Newspapers	(29)	2710				
Periodicals	(30)	2720				
Books	(30)	2730				
Business forms, blank books	(30)	2760	2782			
Commercial printing	(30)	2751	2752			
Other printing, publishing	(30)	2740	2753	2770	2789	2790
Empty						
Empty						
Empty						
Industrial chemicals	(31)	2810				
Fertilizers	(32)	2871	2872			
Pesticides & agric. chem.	(32)	2879				
Misc chemical products	(33)	2860	2890			
Plastic mat'ls. & resins	(34)	2821				
Synthetic rubber	(34)	2822				
Cellulosic fibers	(34)	2823				
Non-cellulosic fibers	(34)	2824				
Drugs	(35)	2830				
Cleaning & toilet products	(36)	2840				
Paints	(37)	2850				

Empty					
Petroleum refining <sup>1</sup>	(38)	2911	2990		
Fuel oil <sup>1</sup>	(38)	2911			
Paving and asphalt	(38)	2950			
Empty					
Tires and inner tubes	(39)	3010			
Rubber products	(40)	3020	3030	3060	
Misc plastic products	(41)	3070			
Leather & ind lthr products	(42)	3110	3120		
Footwear (exc. rubber)	(43)	3130	3140		
Other leather products	(43)	3150	3160	3170	3190
Glass	(44)	3210	3220	3230	
Structural clay products	(45)	3250			
Pottery	(45)	3260			
Cement, concrete, gypsum	(45)	3240	3270		
Other stone & clay products	(45)	3280	3290		
Steel	(46)	3310	3320	3391	3399
Copper	(47)	3331	3340	3351	3362
Lead	(47)	3332			
Zinc	(47)	3333			
Aluminum	(47)	3334	3352	3361	
Oth prim non-fer metals	(47)	3339			
Oth non-fer roll & draw	(47)	3356			
Non-ferrous wire drawing	(47)	3357			
Non-fer casting & forging	(47)	3369	3392		
Metal cans	(48)	3410			
Metal barrels and drums	(48)	3491			
Plumbing & heating equip.	(49)	3430			
Boiler shops	(50)	3443			
Oth structural metal prod.	(50)	3441	3442	3444	3446 3449
Screw machine products	(51)	3450			
Metal stampings	(51)	3460			
Cutlery, hand tools, hardwr	(52)	3420			
Misc fabricated wire prod.	(52)	3480			
Pipes, valves, fittings	(52)	3494	3498		

Sector 76 shows shipments of all petroleum refining. However, all fuel oil is sold to sector 77; therefore, the sales to other sectors show purchases of gasoline, aviation fuel, and petrochemical feedstocks. The distribution of sales for sector 77 shows purchases of residual and stillate fuel oil, diesel fuel, and kerosene.

111	Engines and turbines	(53)	3510			
112	Farm machinery	(54)	3520			
113	Constr, mine, oilfield mach	(55)	3531	3532	3533	
114	Materials handling mach.	(55)	3534	3535	3536	3537
115	Mach. tools, metal cutting	(56)	3541			
116	Mach. tools, metal forming	(56)	3542			
117	Other metal working mach.	(56)	3544	3545	3548	
118	Special industrial mach.	(57)	3550			
119	Pumps, compressors, blowers	(58)	3561	3564		
120	Ball and roller bearings	(58)	3562			
121	Power transmission equip.	(58)	3566			
122	Industrial patterns	(58)	3565	3567	3569	
123	Computers & related mach.	(60)	3571	3573	3574	
124	Other office machinery	(60)	3572	3576	3579	
125	Service industry machinery	(61)	3580			
126	Machine shop products	(59)	3590			
127	Empty					
128	Empty					
129	Elec. measuring instrument	(62)	3611			
130	Transformers & switchgear	(62)	3612	3613		
131	Motors and generators	(63)	3621			
132	Industrial controls	(63)	3622			
133	Welding app. graphite prod.	(63)	3623	3624	3629	
134	Household appliances	(64)	3630			
135	Elec. lighting & wiring eq.	(65)	3640			
136	Radio and TV receiving	(66)	3651			
137	Phonograph records	(66)	3652			
138	Communication equipment	(67)	3660			
139	Electronic components	(68)	3670			
140	Batteries	(69)	3691	3692		
141	Engine electrical equipment	(69)	3694			
142	X-ray, elec. equip, NEC	(69)	3693	3699		
143	Empty					
144	Truck, bus, trailer bodies	(70)	3713	3715		
145	Motor vehicles	(70)	3711	3714	3717	
146	Empty					
147	Aircraft	(71)	3721			
148	Aircraft engines	(71)	3722			
149	Aircraft equipment, NEC	(71)	3723	3729		
150	Ship and boat building	(72)	3730			
151	Railroad equipment	(73)	3740			

153	Trailer coaches	(74)	3791				
154	Empty						
155	Empty						
156	Engr. & scientific instr.	(75)	3810				
157	Mech. measuring devices	(76)	3820				
158	Optical & ophthalmic goods	(78)	3830	3850			
159	Medical & surgical instr.	(77)	3840				
160	Photographic equipment	(78)	3860				
161	Empty						
162	Watches and clocks	(78)	3870				
163	Jewelry and silverware	(79)	3910	3961			
164	Toys, sport, musical instr.	(79)	3930	3940			
165	Office supplies	(79)	3950				
166	Misc manufacturing, NEC	(79)	3962	3963	3964	3980	
			3994	3995	3996	3999	
167	Railroads	(80)	4000	4740			
168	Buses and local transit	(82)	4100				
169	Trucking	(81)	4200	4730			
170	Water transportation	(82)	4400				
171	Airlines	(83)	4500				
172	Pipelines	(82)	4600				
173	Freight forwarding	(82)	4700	-4730	-4740		
174	Telephone and telegraph	(85)	4800	-4830			
175	Radio and TV broadcasting	(85)	4830				
176	Electric utilities	(87)	4910	4930			
177	Empty						
178	Natural gas	(88)	4920	4930			
179	Water and sewer services	(88)	4930	4940	4950	4960	
180	Wholesale trade	(84)	5000				
181	Retail trade	(84)	5200	5300	5400	5500	
			5800	5960	7390		
182	Banks, credit agen., brokers	(86)	6000	6100	6200	6700	
183	Insurance	(86)	6300				
184	Owner-occupied dwellings	( 0)	6400				
185	Real estate	(86)	6500	6600	-6561		
186	Hotel and lodging places	(86)	7000				
187	Personal & repair services	(86)	7200	7600	-7692	-7694	
188	Business services	(86)	7300	7692	8100	8900	
			-8921				
189	Advertising	(86)	7310				

191	Movies & amusements	(86)	7800	7900		
192	Medical services	(86)	0722	8010	8020	8030
			8070	8090		
193	Private schools & NPO	(86)	8200	8400	8600	8921
194	Post office					
195	Fed and S&L Gov. enterprises					
196	Non-competitive imports					
197	Business travel (dummy)					
198	Office supplies (dummy)					
199	Unimportant ind. (dummy)					
200	Computer rental (dummy)					



## INPUT-OUTPUT ECONOMICS.

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There are three principal components to the methodology: generic economies, defining representative technologies, and component proportions. Background for each of these topics, as appropriate methodology is presented below:

## 1.0 Delineation of Generic Economies

### 1.1 Background

A final demand change in a local economy will produce an effect, the level of which will vary with the industrial structure of the economy. Multiplier estimation, then, must be undertaken within the context of a given industrial structure. Since this paper is taking a regional perspective, the task becomes one of aggregating local area information to a regional level. The aggregation, however, must be achieved in a manner that reasonably depicts the qualitative characteristics of the regional industrial structure that reasonably depicts the qualitative characteristics of the economies being aggregated. On this basis generic regional economies are defined as outlined below.

### 1.2 Methodology

- o Divide the national economy into two categories: Standard Metropolitan Statistical Areas (SMSA's) and non-SMSA areas (see figure 3 in section I of the BEA economic areas (see figure 3 in section I of the map of BEA economic areas));
- o Subdivide the above two categories into large and small areas on employment levels; and
- o Subdivide the above four areas according to geographical location and rates of employment growth over the period 1971-1980.

The size of a multiplier impact in a local economy is determined not only by the local industrial structure but also by the characteristics of the activity initiating the local economic perturbation. Varying input requirements will engender varying impacts in different local economies. In order to allow for this aspect of multiplier estimation, input requirements for conventional and solar technologies were assembled. Three technologies from this set were selected to represent a range of possible energy technology alternatives. The selected technologies are representative of the input requirements for three general types of energy technology alternatives: conventional electric generation facilities; centralized solar collector facilities; and solar collector facilities. The type of facilities not represented in this scheme are biomass technologies. The input requirements for these facilities were estimated such that no one technology represented them well. Research on multiplier impact associated with biomass technologies should be done on a case by case basis as generalizations from a single technology would be misleading. Inputs for centralized wood-fired steam technologies are, however, to be similar to those for the technologies used in centralized conventional electric generation facilities." Similar assumptions are applicable to passive solar technologies. An appropriate approach in the case of passive might be to examine input requirements for residential or commercial building construction. The methodology for choosing the three representative technologies is outlined in Exhibit E-1. This methodology also yields the direct component of the multiplier.

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\*See exhibit E-1 for a more detailed listing of the representative technologies.

\*\*It should be noted, however, that solar thermal electric plants are similar in input requirements to the centralized conventional electric generation facilities, but have less input requirements than to wind energy conversion systems (WECS).

- o Group technologies qualitatively (i.e., centralized and decentralized solar, decentralized solar);
- o Regress the input requirements of each technology in the input requirements of the other technologies in the group;
- o Use the values of the coefficients of determination and the regressions to decide which technology in each group is representative of all technologies in the group; and
- o Screen the technologies chosen on the basis of the regression analysis to ensure wide geographic applicability and implementation probability.

## 0 Calculation of the Indirect Component of Regional Multipliers

### 3.1 Background

The indirect component of the multiplier is estimated on the basis of research conducted by the BEA/RIMS staff. This research developed an equation which estimates the indirect component as a function of the direct component and several variables describing the structure of the impact region. The methodology for this research is outlined below.

### 3.2 Methodology

- o Assemble the data needed to estimate the indirect component of regional multipliers via the BEA/RIMS methodology;\*

---


$$I_j^t = e^{B_i(D_j^t)} \quad 1.103$$

are

$I_j^t$  = indirect input of the multiplier associated with the  $t^{\text{th}}$  technology

$B_i$  = a combination of the several variables describing the structure of the  $i^{\text{th}}$  region

$D_j^t$  = the  $j^{\text{th}}$  direct input of the multiplier associated with the  $t^{\text{th}}$  technology

$S_2^r$  = the regional total non-government earnings pr  
of U.S. total non-government earnings in the

$D_j^t$  = the  $j^{\text{th}}$  input requirement of the  $t^{\text{th}}$  technolo

$k$  = the parameter associated with the  $K^{\text{th}}$  variabl  
RIMS multiplier estimation equation

- o Combine the region and technology specific data with t  
parameters in the manner indicated by the RIMS specifi  
derive estimates of the indirect component of regional  
associated with a given technology; and
- o Use  $D_j^t$  and  $I_j^t$  to derive the direct component proportio  
impact technology for the regiona delineated in (1) ab

1. Centralized Conventional Energy Technologies

Coal-fired Steam Electric

Strategic Environmental

Oil-fired Steam Electric\*

System, Working Paper

Gas-fired Steam Electric

for the Energy Invest

Nuclear Reactor

Module

2. Solar Collector Technologies

SHACOB Active System

MITRE Corporation, Sys

and Engineering Cost

Technologies, Vol. II.

AIPH Flat Plate Hot Water System

Ibid., Vol. III, pp. 4

AIPH Parabolic Trough Steam System\*

Ibid., Vol. III, pp. 5

AIPH Parabolic Dish Total Energy  
System

Ibid., Vol. III, p. 6

Residential Photovoltaics

Ibid., Vol. VIII, pp.

Centralized Photovoltaics

Ibid., Vol. VIII, pp.

• Centralized Wind Energy Conversion System\*

Ibid., Vol. VI, p. 8

$S_2^r$  = the regional total non-government earnings proportion of U.S. total non-government earnings in the region

$D_j^t$  = the  $j^{\text{th}}$  input requirement of the  $t^{\text{th}}$  technology

$k$  = the parameter associated with the  $K^{\text{th}}$  variable in the RIMS multiplier estimation equation

- o Combine the region and technology specific data with the parameters in the manner indicated by the RIMS specific equations to derive estimates of the indirect component of regional multiplier associated with a given technology; and
- o Use  $D_j^t$  and  $I_j^t$  to derive the direct component proportion of impact technology for the regiona delineated in (1) above

## Technologies

Coal-fired Steam Electric

Oil-fired Steam Electric\*

Gas-fired Steam Electric

Nuclear Reactor

Strategic Environment

System, Working Paper

for the Energy Invest

Module

### 2. Solar Collector Technologies

SHACOB Active System

MITRE Corporation, S

and Engineering Cos

Technologies, Vol. I

AIPH Flat Plate Hot Water System

Ibid., Vol. III, pp.

AIPH Parabolic Trough Steam System\*

Ibid., Vol. III, pp.

AIPH Parabolic Dish Total Energy  
System

Ibid., Vol. III, p.

Residential Photovoltaics

Ibid., Vol. VIII, pp

Centralized Photovoltaics

Ibid., Vol. VIII, pp

### 3. Centralized Wind Energy Conversion System\*

Ibid., Vol. VI, p. 8

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\*Indicates a representative technology.



065	Akron, OH	S	ENC	266,564
040	Albany, GA	S	SE	45,952
007	Albany-Schenectady- Troy, NY	L	NE	339,491
160	Albuquerque, NM	S	Mtn	174,123
117	Alexander, LA	S	WSC	55,517
018	Allentown-Bethlehem- Easton, PA-NJ	S	NE	274,344
016	Altoona, PA	S	NE	55,569
135	Amarillo, TX	S	WSC	77,108
180	Anaheim-Santa Ana- Garden Grove, CA <sup>@</sup>	L	Pac.	688,317
182	Anchorage, AK <sup>@</sup>	S	Pac.	94,480
078	Anderson, IN <sup>@</sup>	S	WSC	58,275
071	Ann Arbor, MI	S	WNC	131,283
049	Anniston, AL	S	SE	51,584
094	Appleton-Oshkosh, WI	S	ENC	131,400
030	Asheville, NC	S	SE	77,427
036	Atlanta, GA	L	SE	896,499
018	Atlantic City, NJ	S	NE	79,538
035	Augusta, GA-SC	S	SE	137,900

119	Bakersfield, CA	S	Pac	164,179
019	Baltimore, MD	L	SE	968,090
114	Baton Rouge, LA <sup>@</sup>	S	WSC	183,876
074	Battle Creek, MI	S	WNC	75,752
072	Bay City, MI <sup>@</sup>	S	WNC	39,294
121	Beaumont-Port Arthur-Orange, TX	S	WSC	152,433
155	Billings, MT	S	Mtn	48,970
113	Biloxi-Gulfport, MS	S	SE	76,227
011	Binghamton, NY-PA	S	NE	122,983
049	Birmingham, AL	L	SE	364,203
079	Bloomington, IN	S	ENC	40,856
087	Bloomington-Normal, IL	S	ENC	53,180
167	Boise City, ID	S	Mtn	75,419
004	Boston-Lowell- Brockton-Lawrence- Haverhill, MA-NH	L	N.Eng.	1,781,045
044	Bradenton, FL <sup>@</sup>	S	SE	40,609
012	Bridgeport-Stamford- Norwalk-Danbury, CT	L	NE	345,532

131	Brownsville- Harlingen-San Benito, TX	S	WSC	61,903
122	Bryan-College Station, TX	S	WSC	32,236
010	Buffalo, NY <sup>@</sup>	L	NE	532,816
003	Burlington, VT	S	NE	51,522
028	Burlington, NC <sup>@</sup>	S	SE	46,993
065	Canton, OH	S	ENC	162,717
100	Cedar Rapids, IA	S	WNC	82,088
084	Champaign-Urbana- Rantoul, IL	S	ENC	81,050
034	Charleston-North Charleston, SC	S	SE	169,249
060	Charleston, WV	S	SE	118,414
029	Charlotte-Gastonia, NC	L	SE	322,886
051	Chattanooga, TN-GA	S	SE	184,493
156	Cheyenne, WY	S	Mtn	33,442
083	Chicago, IL	L	ENC	3,294,038
067	Cincinnati, OH-KY-IN	L	ENC	602,393
054	Clarksville- Hopkinsville, TN-KY <sup>@</sup>	S	SE	74,496
065	Cleveland, OH	L	ENC	932,681

156	Colorado Springs, CO	S	Mtn	150
106	Columbia, MO	S	WNC	47
032	Columbia, SC	S	SE	187
037	Columbus, GA-AL <sup>@</sup>	S	SE	108
066	Columbus, OH	L	ENC	489
130	Corpus Christi, TX	S	WSC	124
125	Dallas-Fort Worth, TX	L	WSC	1,288
099	Davenport-Rock Island-Moline, IA-IL	S	ENC/WNC	180
068	Dayton, OH	L	ENC	380
042	Daytona Beach, FL	S	SE	74
085	Decatur, IL	S	ENC	61
157	Denver-Boulder, CO	L	Mtn	717
104	Des Moines, IA	S	WNC	187
071	Detroit, MI	L	ENC	1,788
098	Dubuque, IA	S	WNC	47
095	Duluth-Superior, MN-WI	S	ENC/WNC	115
092	Eau Claire, WI	S	ENC	51
133	El Paso, TX	S	WSC	173
011	Elmira, NY <sup>@</sup>	S	NE	40

Economic				
<u>Area Number</u>	<u>Region</u>	<u>Size*</u>	<u>Location**</u>	<u>Employment</u>
015	Erie, PA	S	NE	120,523
173	Eugene-Springfield, OR	S	Pac	100,104
080	Evansville, IN-KY	S	ENC/SE	135,973
149	Fargo-Moorhead, ND- MN	S	WNC	68,508
026	Fayetteville, NC	S	SE	112,809
109	Fayetteville- Springdale, AR	S	WSC	69,671
071	Flint, MI	S	ENC	196,955
050	Florence, AL	S	SE	51,048
157	Fort Collins, CO	S	Mtn	49,239
043	Fort Lauderdale- Hollywood, FL	S	SE	288,478
044	Fort Myers, FL <sup>@</sup>	S	SE	52,662
110	Fort Smith, AR-OK	S	WSC	77,263
076	Fort Wayne, IN	S	ENC	185,324
179	Fresno, CA	S	Pac	220,822
049	Gadsden, AL <sup>@</sup>	S	SE	35,043
041	Gainesville, FL	S	SE	61,941
122	Galveston-Texas City, TX	S	WSC	75,623
083	Gary-Hammond-East Chicago, IN	S	ENC	261,260

Grand Rapids, MI	S	ENC	260,052	2.437
Great Falls, MI	S	Mtn	38,930	1.807
Greeley, CO	S	Mtn	45,250	5.904
Green Bay, WI	S	ENC	76,316	3.216
Greensboro-Winston Salem-High Point, NC	L	SE	406,426	1.634
Greenville- Spartanburg, SC	S	SE	258,073	2.638
Hamilton-Middleton, OH	S	ENC	86,517	1.071
Harrisburg, PA	S	NE	225,613	1.796
Hartford-New Britain- Bristol, CT	L	NE	511,088	1.273
Honolulu, HI	L	Pac	373,277	2.219
Houston, TX <sup>@</sup>	L	WSC	1,217,678	5.656
Huntington-Ashland, WV-KY-OH	S	ENC	113,079	1.018
Huntsville, AL	S	SE	126,770	1.406
Indianapolis, IN	L	ENC	545,634	1.501
Jackson, MI	S	ENC	58,105	0.854
Jackson, MS	S	ESC	149,841	2.980
Jacksonville, FL	L	SE	315,057	2.400

052	Johnson City- Kingsport-Bristol, TN-VA	S	SE	167,
016	Johnstown, PA	S	NE	99,
074	Kalamazoo-Portage, MI	S	ENC	117,
083	Kankakee, IL	S	ENC	43,
105	Kansas City, MO-KS	L	WNC	642,
083	Kenosha, WI	S	ENC	46,
124	Killeen-Temple, TX <sup>@</sup>	S	WSC	108,
053	Knoxville, IN	S	SE	200,
077	Kokomo, IN	S	ENC	51,
091	LaCrosse, WI	S	WSC	43,
115	Lafayette, LA	S	WSC	65,
082	Lafayette-West Lafayette, IN	S	ENC	55,
116	Lake Charles, LA	S	WSC	61,
044	Lakeland-Winter Haven, FL	S	SE	115,
017	Lancaster, PA	S	NE	159,
074	Lansing, East Lansing, MI	S	ENC	196,
129	Laredo, TX	S	WSC	27,

Lawrence, KS	S	WNC	26,905	3.0930
Lawton, OK	S	WSC	52,292	1.2957
Lewiston-Auburn, ME	S	NE	41,313	1.6406
Lexington-Fayette, KY	S	SE	156,919	3.3285
Lima, OH	S	ENC	94,747	0.8655
Lincoln, NE	S	WNC	101,320	2.8453
Little Rock-North Little Rock, AR	S	WSC	187,959	2.9930
Long Branch-Asbury Park, NJ	S	NE	162,696	0.9683
Longview, TX	S	WSC	62,588	3.3084
Lorain-Elyria, OH	S	ENC	97,145	0.9542
Los Angeles-Long Beach, CA	L	PAC	3,423,270	1.6727
Louisville, KY-IN	L	ENG	406,641	0.7181
Lubbock, TX	S	WSC	92,404	4.1464
Lynchburg, VA	S	SE	72,755	1.8065
Macon, GA	S	SE	113,369	1.2872
Madison, WI	S	ENC	168,011	2.6990
Manchester-Nashua, NH	S	NE	120,509	1.9335



<u>Area Number</u>	<u>Region</u>	<u>Size</u>	<u>Location</u>	<u>Employment</u>
065	Mansfield, OH <sup>@</sup>	S	ENC	58,673
131	McAllen-Pharr- Edinburg, TX <sup>@</sup>	S	WSC	73,281
042	Melbourne-Titusville- Cocoa, FL	S	SE	90,515
055	Memphis-TN-AR-MS	L	ESC/WSC	400,661
043	Miami, FL	L	SE	682,665
132	Midland, TX	S	WSC	36,060
089	Milwaukee, WI	L	ENC	671,969
096	Minneapolis-St Paul, MN-WI	L	WNC/ENC	1,019,790
047	Mobile, AL	S	SE	159,465
178	Modesto, CA	S	Pac	99,231
118	Monroe, LA	S	WSC	52,520
048	Montgomery, AL	S	SE	117,619
078	Muncie, IN <sup>@</sup>	S	ENC	50,342
073	Muskegon-Norton Shores-Muskegon Heights, MI	S	ENC	66,401
054	Nashville-Davidson, IN	L	SE	380,581
012	Nassau-Suffolk, NY	L	NE	903,939
004	New Bedford-Fall River, MA	S	NE	187,235

<u>Region</u>	<u>Size</u>	<u>Location</u>	<u>Employment</u>	<u>Growth Rate</u>
New Brunswick-Perth Amboy-Sayreville, NJ	S	NE	258,164	2.1927
New Haven-Waterbury- Meriden, CT	L	NE	323,098	0.3366
New London-Norwich, CT	S	NE	111,272	2.2807
New Orleans, LA	L	WSC	513,662	2.6275
New York, NY-NJ <sup>@</sup>	L	NE	4,369,171	-1.6770
Newark, NJ <sup>@</sup>	L	NE	930,498	-0.1271
Newport News-Hampton, VA	S	SE	165,285	1.7246
Norfolk-Virginia Beach-Portsmouth, VA-NC	L	SE	355,964	1.5633
Northeast Pennsylvania, PA	S	NE	254,463	0.0559
Odessa, TX	S	WSC	47,455	5.0216
Oklahoma City, OK	L	WSC	361,199	1.9334
Omaha, NE-IA	S	WNC	278,763	1.5167
Orlando, FL <sup>@</sup>	S	SE	262,744	5.1940
Owensboro, KY <sup>@</sup>	S	SE	34,813	0.4430
Oxnard-Simi Valley- Ventura, CA	S	Pac	152,582	3.9871
Panama City, FL	S	SE	36,837	3.8178

047	Pascagoula-Moss Point, MS <sup>@</sup>	S	SE	55,515
012	Paterson-Clifton- Passaic, NJ <sup>@</sup>	S	NE	194,983
046	Pensacola, FL	S	SE	109,189
087	Peoria, IL	S	ENC	172,503
022	Petersburg-Colonial Heights-Hopewell, VA <sup>@</sup>	S	SE	57,818
018	Philadelphia, PA-NJ <sup>@</sup>	L	NE	2,026,371
162	Phoenix, AZ	L	Mtn	518,770
111	Pine Bluff, AR	S	Mtn	33,909
016	Pittsburgh, PA	L	NE	976,223
006	Pittsfield, MA	S	NE	65,454
002	Portland, ME	S	NE	115,393
172	Portland, OR-WA	L	Pac	525,289
012	Poughkeepsie, NY	S	NE	96,789
005	Providence-Warwick- Pawtucket, RI	L	NE	384,293
165	Provo-Orem, UT	S	Mtn	55,500
158	Pueblo, CO	S	Mtn	52,172

027	Raleigh-Durham, NC	S	SE	255,686
018	Reading, PA	S	NE	142,578
164	Reno, NV	S	Mtn	86,926
169	Richland-Kennewick, WA <sup>@</sup>	S	WNC	53,918
022	Richmond, VA	L	SE	325,001
180	Riverside-San Bernardino-Ontario, CA	L	Pac	443,151
021	Roanoke, VA	S	SE	109,315
097	Rochester, MN	S	WNC	50,410
009	Rochester, NY	L	NE	435,305
088	Rockford, IL	S	ENC	126,026
177	Sacramento, CA	L	Pac	383,377
072	Saginaw, MI	S	ENC	93,057
096	St Cloud, MN	S	WNC	60,551
105	St. Joseph, MO <sup>@</sup>	S	WNC	43,793
107	St. Louis, MO-IL	L	WNC/ENC	1,064,540
172	Salem, OR	S	Pac	91,760
176	Salinas-Seaside- Monterey, CA <sup>@</sup>	S	Pac	133,731

128	San Angelo, TX	S	WSC	35,752
129	San Antonio, TX	L	WSC	422,618
181	San Diego, CA	L	Pac	685,027
176	San Francisco- Oakland, CA <sup>@</sup>	L	Pac	1,546,799
176	San Jose, CA	L	Pac	553,972
180	Santa Barbara-Santa Maria-Lompoc, CA	S	Pac	123,716
176	Santa Cruz, CA	S	Pac	57,739
176	Santa Rosa, CA	S	Pac	88,610
044	Sarasota, FL	S	SE	61,068
039	Savannah, GA	S	SE	97,418
171	Seattle-Everett, WA	L	Pac	657,208
125	Sherman-Dension, TX <sup>@</sup>	S	WSC	35,208
117	Shreveport, LA	S	WSC	160,475
103	Sioux City, IA-NE	S	WNC	60,295
147	Sioux Falls, SD	S	WNC	54,839
075	South Bend, IN	S	ENC	123,012
168	Spokane, WA	S	Pac	131,293
085	Springfield, IL	S	ENC	97,944

	Springfield, MO	S	WNC	89,815	2.9
8	Springfield, OH <sup>@</sup>	S	ENC	65,843	-0.1
6	Springfield-Chicopee-Holyoke, MA	S	NE	236,304	0.1
3	Steubenville-Weirton, OH-WV	S	ENC/SE	69,616	0.1
3	Stockton, CA	S	Pac	141,188	3.1
3	Syracuse, NY	S	NE	266,057	0.1
1	Tacoma, WA <sup>@</sup>	S	Pac	170,110	0.1
6	Tallahassee, FL	S	SE	62,677	4.1
4	Tampa-St. Petersburg, FL	L	SE	504,194	3.1
1	Terre Haute, IN	S	ENC	70,564	0.1
0	Texarkana, TX-Texarkana, AR <sup>@</sup>	S	WSC	50,087	1.1
0	Toledo, OH-MI	L	ENC	318,179	0.1
1	Topeka, KS <sup>@</sup>	S	WNC	90,710	0.1
3	Trenton, NJ	S	NE	167,285	1.1
1	Tucson, AZ	S	Mtn	172,708	3.1
4	Tulsa, OK	S	WSC	290,637	4.1
0	Tuscaloosa, AL	S	SE	53,600	2.1
0	Tyler, TX	S	WSC	52,679	3.4

176	Vallejo-Fairfield- Napa, CA	S	Pac	115,183
018	Vineland-Millville- Bridgeton, NJ	S	NE	58,242
124	Waco, TX	S	WSC	71,325
020	Washington, DC-MD-VA	L	SE	1,590,643
101	Waterloo-Cedar Falls, IA	S	WNC	66,539
043	West Palm Beach, Boca Raton, FL	S	SE	179,249
063	Wheeling, WV-OH	S	ENC	73,868
139	Wichita, KS	S	WNC	207,349
126	Wichita Falls, TX <sup>@</sup>	S	WSC	66,416
014	Williamsport, PA	S	NE	51,566
018	Wilmington, DE-NJ- MD	S	SE	239,178
025	Wilmington, NC	S	SE	54,392
004	Worcester-Fitchburg- Leominster, MA	S	NE	272,506
170	Yakima, WA	S	Pac	73,466
017	York, PA	S	NE	156,469
064	Youngstown-Warren, OH	S	ENC	222,031

SE = Southeast

ENC = East North Central

WNC = West North Central

WSC = West South Central

Mtn = Mountain

Pac = Pacific

areas excluded on the basis of statistical consideration.



2	Portland-Lewiston, ME	S	NE	162,137
3	Burlington, VT	L	NE	186,299
4	Boston, MA@	S	NE	165,701
5	Providence-Warwick- Pawtucket, RI@	S	NE	29,360
6	Hartford-New Haven- Springfield, CT-MA	S	NE	162,155
7	Albany-Schenectady- Troy, NY	S	NE	159,447
8	Syracuse-Utica, NY	S	NE	139,027
9	Rochester, NY	S	NE	44,885
10	Buffalo, NY	S	NE	145,280
11	Binghamton-Elmira, NY	S	NE	174,019
12	New York, NY	L	NE	303,427
13	Scranton-Wilkes- Barre, PA	S	NE	46,911
14	Williamsport, PA	L	NE	198,768
15	Erie, PA	S	NE	95,050
16	Pittsburgh, PA	L	NE	218,045
17	Harrisburg-York- Lancaster, PA	S	NE	133,592

Philadelphia, PA	L	NE	358,003	0.8701
Baltimore, MD	S	SE	123,371	1.9186
Washington, DC	L	SE	263,869	1.7576
Roanoke-Lynchburg, VA	L	SE	312,266	1.4579
Richmond, VA	S	SE	172,743	1.6454
Norfolk-Virginia Beach-Newport News, VA	S	SE	69,873	1.8020
Rocky Mount-Wilson- Greenville, NC	L	SE	334,569	2.3502
Wilmington, NC	S	SE	104,106	0.6603
Fayetteville, NC	S	SE	105,457	1.9268
Raleigh-Durham, NC	S	SE	139,524	1.6633
Greensboro-Winston- Salem-High Point, NC	S	SE	158,422	1.6130
Charlotte, NC	L	SE	424,838	1.1374
Asheville, NC	S	SE	106,664	2.3578
Greenville- Spartanburg, SC	S	SE	171,520	1.2994
Columbia, SC	S	SE	136,958	1.8967
Florence, SC	L	SE	197,484	2.1233

	Charleston, SC	S	SE	11,456
35	Augusta, GA	S	SE	69,394
36	Atlanta, GA	L	SE	332,446
37	Columbus, GA	S	SE	97,939
38	Macon, GA <sup>@</sup>	S	SE	92,975
39	Savannah, GA	S	SE	138,923
40	Albany, GA	S	SE	158,649
41	Jacksonville, FL	S	SE	137,772
42	Orlando-Melbourne- Daytona Beach, FL	S	SE	40,615
43	Miami-Fort Lauderdale, FL	S	SE	99,582
44	Tampa-St. Petersburg, FL <sup>@</sup>	S	SE	74,645
45	Tallahassee, FL	S	SE	47,366
46	Pensacola-Panama City, FL	S	SE	59,729
47	Mobile, AL	S	SE	68,703
48	Montgomery, AL	L	SE	200,601
49	Birmingham, AL	S	SE	142,237
50	Huntsville-Florence, AL	S	SE	67,654

51	Chattanooga, TN	S	SE	163,634	3
52	Johnson City- Kingsport-Bristol, TN,VA	S	SE	151,991	2
53	Knoxville, TN	L	SE	186,650	2
54	Nashville, TN	L	SE	312,453	2
55	Memphis, TN	L	SE	679,883	1
56	Paducah, KY	S	SE	96,726	1
57	Louisville, KY	S	SE	148,780	0
58	Lexington, KY	L	SE	197,546	2
59	Huntington, WV	S	SE	108,659	3
60	Charleston, WV	S	SE	123,805	3
61	Morganton-Fairmont, WV	S	SE	130,504	1
62	Parkersburg, WV <sup>@</sup>	S	SE	8,099	4
63	Wheeling-Steubenville- Wiarton, WV-OH	S	SE/ENC	24,333	1
64	Youngstown-Warren, OH	S	ENC	122,136	0
65	Cleveland, OH	L	ENC	234,857	1
66	Columbus, OH	L	ENC	287,287	0
67	Cincinnati, OH	S	ENC	103,700	1

68	Dayton, OH	S	ENC	55,019
69	Lima, OH	S	ENC	28,164
70	Toledo, OH	S	ENC	136,479
71	Detroit, MI	S	ENC	13,507
72	Saginaw-Bay City, MI	L	ENC	185,052
73	Grand Rapids, MI	S	ENC	149,017
74	Lansing-Kalamazoo, MI	S	ENC	30,631
75	South Bend, IN	L	ENC	228,277
76	Fort Wayne, IN	S	ENC	90,883
77	Kokomo-Marion, IN	S	ENC	88,965
79	Indianapolis, IN	S	ENC	126,365
80	Evansville, IN	S	ENC	152,542
81	Terre Haute, IN	S	ENC	21,223
82	Lafayette, IN	S	ENC	60,183
83	Chicago, IL	L	ENC	225,685
84	Champaign-Urbana, IL	S	ENC	101,880
85	Springfield-Decatur, IL	S	ENC	76,158
86	Quincy, IL	S	ENC	70,787

87	Peoria, IL	S	ENC	87,833
88	Rockford, IL	S	ENC	115,482
89	Milwaukee, WI	S	ENC	132,701
90	Madison, WI	S	ENC	77,059
91	LaCrosse, WI	S	ENC	84,276
92	EauClaire, WI	S	ENC	46,576
93	Wausau, WI	S	ENC	165,467
94	Appleton-Green Bay- Oshkosh, WI	L	ENC	258,999
95	Duluth, MN	S	WNC	62,784
96	Minneapolis-St Paul, MN	L	WNC	344,602
97	Rochester, MN	S	WNC	73,265
98	Dubuque, IA	S	WNC	83,188
99	Davenport-Rock Island-Moline, IN-IL	S	WNL/ENC	157,210
100	Cedar Rapids, IA	S	WNC	81,173
101	Waterloo, IA	S	WNC	129,572
102	Fort Dodge, IA	S	WNC	130,548
103	Sioux City, IA	S	WNC	133,113
104	Des Moines, IA	L	WNC	221,672

105	Kansas City, MO	L	WNC	201,923
106	Columbia, MO	S	WNC	151,934
107	St. Louis, MO	L	WNC	404,747
108	Springfield, MO	L	WNC	303,226
109	Fayetteville, AR <sup>@</sup>	S	WSC	47,320
110	Fort Smith, AR	S	WSC	62,287
111	Little Rock, North Little Rock, AR	L	WSC	273,340
112	Jackson, MS	L	SE	290,753
113	New Orleans, LA	L	WSC	223,124
114	Baton Rouge, LA	S	WSC	65,948
115	Lafayette, LA	S	WSC	130,870
116	Lake Charles, LA <sup>@</sup>	S	WSC	48,440
117	Shreveport, LA	S	WSC	54,370
118	Monroe, LA	S	WSC	78,978
119	Texarkana, TX	S	WSC	91,971
120	Tyler-Longview, TX	S	WSC	133,199
121	Beaumont-Port Arthur, TX	S	WSC	17,614
122	Houston, TX	S	WSC	171,822
123	Austin, TX	S	WSC	27,429

24	Waco-Killeen- Temple, TX	S	WSC	51,925	0
25	Dallas-Fort Worth, TX	S	WSC	119,864	1
26	Wichita Falls, TX	S	WSC	24,367	1
27	Abilene, TX	S	WSC	65,548	1
28	San Angelo, TX	S	WSC	27,026	1
29	San Antonio, TX	S	WSC	100,356	2
30	Corpus Christi, TX	S	WSC	50,134	0
31	Brownsville-McAllen- Harlingen, TX	S	WSC	9,686	3
32	Odessa-Midland, TX	S	WSC	48,948	1
33	El Paso, TX	S	WSC	114,735	2
34	Lubbock, TX	S	WSC	102,486	1
35	Amarillo, TX	S	WSC	134,922	2
36	Lawton, OK	S	WSC	53,273	1
37	Oklahoma City, OK	L	WSC	215,773	2
38	Tulsa, OK	S	WSC	131,265	2
39	Wichita, KS	L	WNC	218,327	2
40	Salina, KS	S	WNC	120,256	2
41	Topeka, KS	S	WNC	101,663	0



142	LINCOLN, NE	S	WNC	70,100
143	Omaha, NE	S	WNC	117,348
144	Grand Island, NE	S	WNC	174,906
145	Scotts Bluff, NE	S	WNC	50,619
146	Rapid City, SD	S	WNC	108,131
147	Sioux Falls, SD	S	WNC	151,596
148	Aberdeen, SD	S	WNC	61,653
149	Fargo-Moorhead, NE-MN	S	WNC	92,707
150	Grand Folks, ND	S	WNC	86,294
151	Bismarck, ND	S	WNC	70,528
152	Minot, ND	S	WNC	87,247
153	Great Falls, MT <sup>@</sup>	S	Mtn	67,477
154	Missoula, MT	S	Mtn	101,193
155	Billings, MT	S	Mtn	88,144
156	Cheyenne-Casper, WY	S	Mtn	84,777
157	Denver, CO	S	Mtn	47,043
158	Colorado Springs- Pueblo, CO	S	Mtn	65,393
159	Grand Junction, CO <sup>@</sup>	S	Mtn	107,864
160	Albuquerque, NM	S	Mtn	136,027

r	Region	Size*	Location**	1978	1971-1978
				Employment	Growth Rate
	Tucson, AZ <sup>@</sup>	S	Mtn	45,790	0.8944
	Phoenix, AZ	S	Mtn	153,481	3.3128
	Las Vegas, NV <sup>@</sup>	S	Mtn	23,871	1.4346
	Reno, NV	S	Mtn	55,037	4.0601
	Salt Lake City- Ogden, UT	S	Mtn	115,848	5.2319
	Pocatello-Idaho Falls, ID	S	Mtn	168,619	4.8206
	Boise City, ID	S	Mtn	80,958	3.6089
	Spokane, WA	S	Pac	125,894	2.8469
	Richland, WA	S	Pac	73,369	3.2888
	Yakima, WA	S	Pac	79,435	3.4552
	Seattle, WA	L	Pac	250,376	3.4352
	Portland, OR	L	Pac	204,889	3.4508
	Eugene, OR	S	Pac	148,145	3.0841
	Redding, CA	S	Pac	81,508	3.5842
	Eureka, CA	S	Pac	53,033	2.8287
	San Francisco- Oakland-San Jose, CA	S	Pac	43,739	5.5525
	Sacramento, CA	S	Pac	135,731	4.5009

<u>Area Number</u>	<u>Region</u>	<u>Size</u>	<u>Location</u>	<u>Employment</u>	<u>S</u>
178	Stockton-Modesto, CA	S	Pac	81,951	
179	Fresno-Bakersfield, CA	S	Pac	149,703	
180	Los Angeles, CA	S	Pac	59,309	
181	San Diego, CA <sup>@</sup>	S	Pac	45,247	
182	Anchorage, AK <sup>@</sup>	S	Pac	120,879	
183	Honolulu, HI	S	Pac	80,102	

\* S = Small

\* L = Large Non-SMSA's are those with 1976 employment levels above 18

\*\* Legend    NE    =    Northeast

              SE    =    Southeast

              ENC   =    East North Central

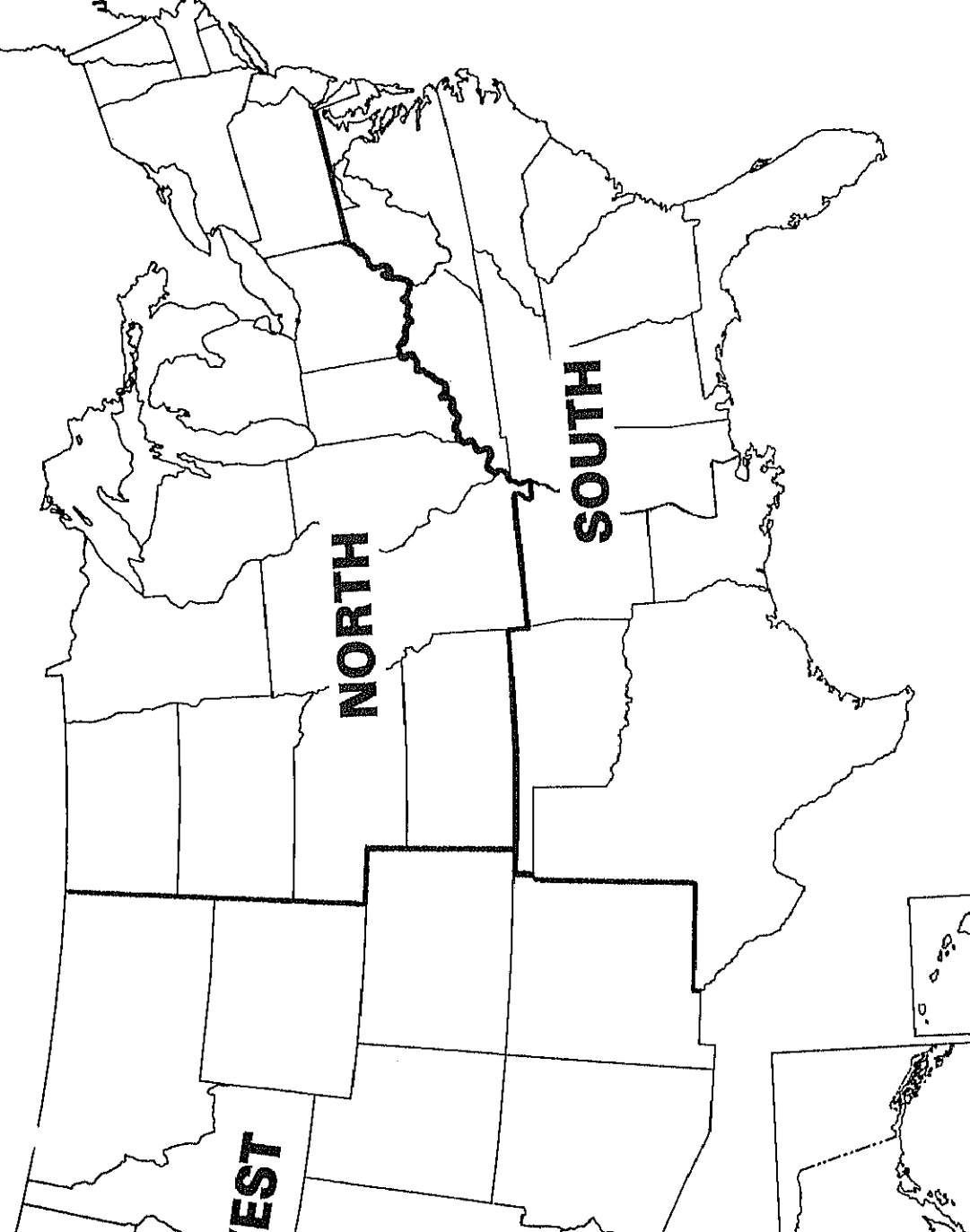
              WNC   =    West North Central

              WSC   =    West South Central

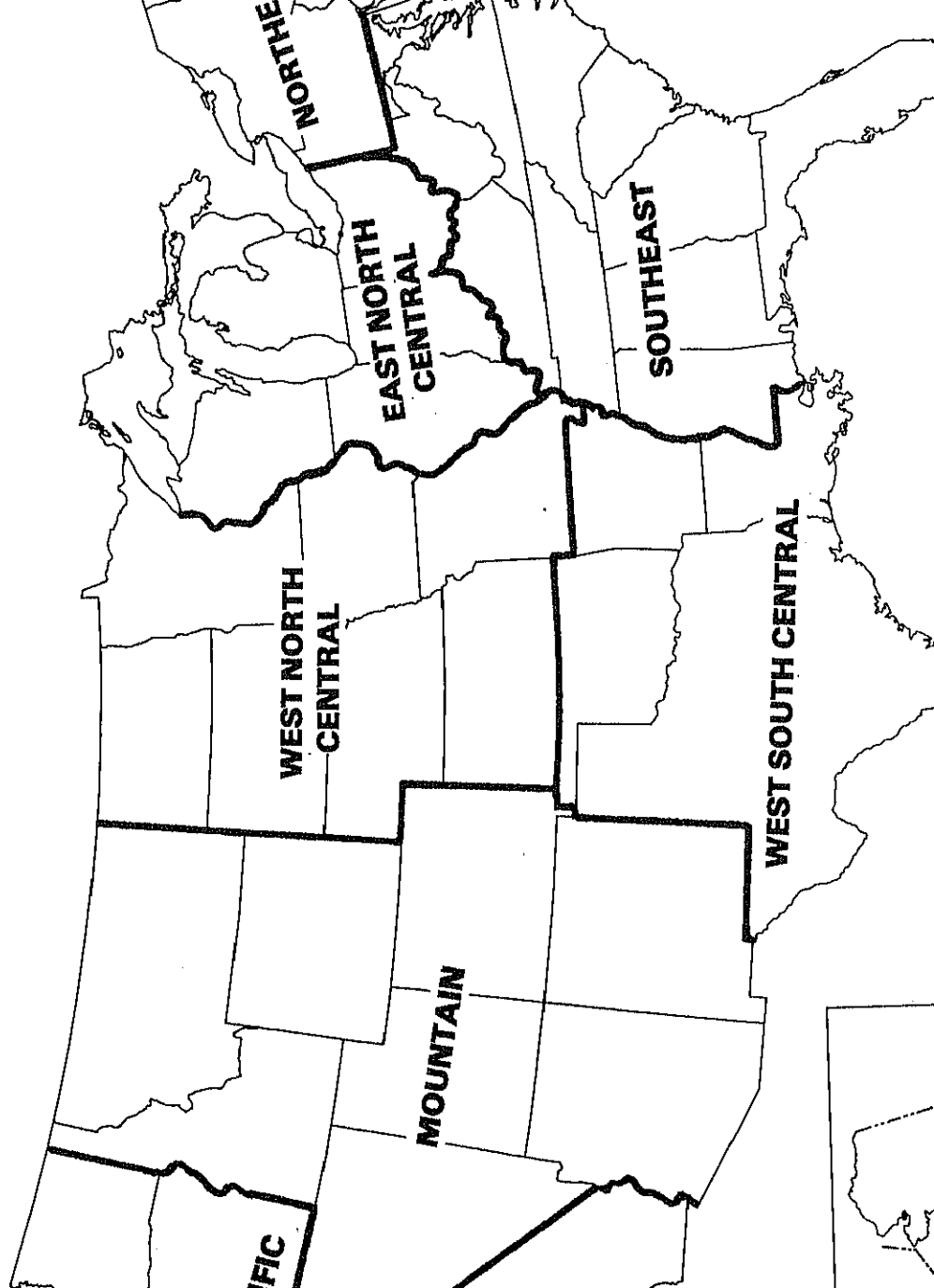
              Mtn   =    Mountain

              Pac    =    Pacific

@ = areas excluded on the basis of statistical consideration.



**Figure E-2: Regions Delineated for Small SMSAs**



**Figure E-3: Regions Delineated for Small Non-SMSAs**

